Operations on the
Survey of India
1891-92 & 1892-93

00134601

BOMBAY BRANCH
OF THE
ROYAL ASIATIC SOCIETY.
TOWN HALL, BOMBAY.

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on 01 February, 2020

INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1897.
REFERENCE
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
GULF OF SIAM

BAY OF BENGAL
INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1891-92.

00134601

PART I.

134601

SUMMARY.

ADMINISTRATION.

1. The operations of the Department that are now reported on are for the survey year ending 30th September 1892.

2. The general administration of the Department and the superintendence of the Topographical Branch remained in the hands of Colonel H. R. Thuillier, R.E., during the year, except for a period of three months while absent on privilege leave, when Colonel G. Strahan, R.E., officiated as Surveyor-General in addition to his other duties. The supervision of the Revenue Branch has been carried on, as before, by Lieutenant-Colonel C. Strahan, R.E., and that of the Trigonometrical Branch by Colonel G. Strahan, R.E. In view of the forthcoming survey and preparation of record of rights in Bihar which have been entrusted to the Survey Department, together with the operations in Orissa and elsewhere in Bengal now in progress, it was considered that such extensive operations should, in the interests of economy and administrative efficiency, be placed under the superintendence of an officer experienced in cadastral-cum-settlement surveys, whose time would be wholly at the command of the Bengal Government. The appointment of Director of Bengal Surveys was therefore created for a term of five years from 1st April 1892, and Lieutenant-Colonel Sandeman was selected for the post and assumed the administrative charge of all cadastral surveys in Bengal from that date. Lieutenant-Colonel Sandeman, however, obtained furlough for six months from the 18th April, 1892, and the superintendence of these parties remained in the hands of the Deputy Surveyor-General in charge of Revenue Surveys during this period.

Inspection tours of the Administrative Officers.

3. The Surveyor-General left Calcutta on the 7th April, 1892, for Madras and returned on the 29th idem, during which time he inspected at Bangalore the office of No. 19 Party, which is employed on forest surveys in the Madras Presidency, and conferred with the Forest Member of the Board of Revenue and the Conservator regarding the operations being carried out in the Madras Presidency. On the 5th May the Surveyor-General proceeded to Simla under the orders of the Government of India, to be in personal communication with them. While at Simla, he inspected the Survey offices located there, *viz.*, the Drawing Office and No. 18 Party. He returned to Calcutta on the 20th July, and proceeded on leave on the 2nd August.

The Officiating Surveyor-General left Calcutta on the 18th August, 1892, on tour to Bangalore and Poona. At Bangalore he inspected the offices of Nos. 11 and 21 Parties and the Mergui detachment, and at Poona those of Nos. 10, 17 and 25 Parties. He returned to Calcutta on the 4th September, and

proceeded to Mussoorie on the 22nd, where he inspected the office of the Aden detachment.

4. The Deputy Surveyor-General, in charge Trigonometrical Branch, proceeded to Simla in October 1892, and inspected the office of No. 18 Party. The recess offices of the other parties under his immediate superintendence were located at his head-quarters and were duly inspected from time to time, *viz.*, those of Nos. 14, 22, 23 and 24 Parties.

5. On the 3rd December, 1891, the Deputy Surveyor-General, Revenue Branch, left Calcutta to inspect No. 2 Party at Chittagong, returning on the 8th idem; whilst at Chittagong he conferred with the Settlement Officer regarding arrangements for the demarcation and survey of the *thanas* of Chakiria, Mashkhal and Teknaf, and on other matters connected with the prosecution of the survey, such as the attendance of the landholders, the neglect of which had caused much delay in some cases. On the 12th January, 1892, he visited Muzaffarpur and inspected the Bihar traverse detachment whilst at work in the field; he also conferred with the Collector on the subject of supplies to the sub-surveyors, there being a scarcity in the district, and on the proper procedure to ensure the attendance of the *zamindars*. On the 26th June, Lieutenant-Colonel C. Strahan proceeded to the Central Provinces, where he inspected the recess office of No. 9 Party at Kampti. On the 2nd July he again went to Muzaffarpur and visited the office of the Bihar traverse detachment; the survey schools for *patwaris* at Muzaffarpur and Motihari were also inspected. On the 9th July, a conference was held with the Commissioner of Patna at Bankipore, at which Mr. McNaughten, the Secretary to the Planters' Association, was present, when the difficulties connected with the employment of *patwaris* as field surveyors, in those parts where the lands of a village were the property of several *zamindars*, were discussed. On 13th August, Lieutenant-Colonel C. Strahan left Calcutta for Burma, returning on the 3rd September: during this time he thoroughly inspected the offices of Nos. 3, 7, 12, and 20 Parties. He also conferred with the Chief Commissioner, the Financial Commissioner, and the Director of Land Records on the subject of the progress of the surveys generally and the programme for 1892-93 for each party. From the 10th to the 21st September he was occupied in proceeding to Assam and inspecting the office of No. 6 Party at Shillong, where also he conferred with the Chief Commissioner and the Acting Director of Land Records, after which he again visited Muzaffarpur. During October he inspected the detachment of No. 5 Party (Garhwal) at Naini Tal, and consulted with the Secretary to the Board of Revenue on the future work required in Garhwal.

6. Prior to Lieutenant-Colonel Sandeman's appointment as Director, Bengal Surveys, he was placed on special duty from the 27th January, 1892, for the purpose of making suitable arrangements for the commencement of the Bihar cadastral survey and for the prosecution of the other surveys in Bengal.

Lieutenant-Colonel Sandeman left Calcutta on the 23rd January, 1892, for Cuttack, where he was joined by the Director of Land Records; a plan of future procedure for the survey of Orissa was then definitely decided on, and this, with some modification, received the sanction of His Honor the Lieutenant-Governor when he inspected the survey and settlement offices there in February. Colonel Sandeman returned to Calcutta on the 8th March, and on the 10th idem proceeded to Chittagong to inspect the party working in that district, returning to Calcutta on the 22nd idem. On the 27th March he proceeded to Bankipore and thence to Muzaffarpur, where a meeting was held under the presidency of the Commissioner of the division, at which the Maharaja of Darbhanga and the principal *zamindars* and planters of Tirhut were present, to consider Colonel Sandeman's plan of carrying out the survey operations by the agency of *patwaris* specially trained for the purpose. In accordance with the decision then arrived at, measures were taken for the instruction of a selected number of *patwaris* during the recess season of 1892.

On the 30th March, Colonel Sandeman proceeded to Darbhanga and inspected the maps and papers of the Maharaja's estate. On the 1st April he went to Raniganj, and discussed with the officer in charge the progress of the detachment working in the Burdwan Raj estates. The Director then proceeded *viâ* Calcutta to Jalpaiguri, where he arrived on the 6th April and inspected No. 4 Party, giving the officer in charge orders regarding the preliminary

arrangements to be made for the conduct of the Bihar operations of the future which that party was to undertake. Colonel Sandeman returned to Calcutta on the 8th April, and proceeded on furlough on the 15th idem.

FIELD PARTIES.

7. Field operations have been carried on during the year under report by 21 parties and 6 small detachments. Of these, one party was employed on trigonometrical surveys; three parties and two detachments on topographical surveys; four parties on forest surveys; seven parties (one of which was of double strength) and two detachments on cadastral surveys; one party and one detachment on traverse surveys; three parties on scientific operations; and two parties and one detachment on geographical surveys. The following tabular statement shows collectively the whole of these operations, grouped according to the scope and nature of the work on which the parties were severally employed:—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Burma	15	Lieutenant C. F. Close, R.E.	.....	D. S. G., Trig.
	Topographical Surveys.				
10	Bombay	16	Major J. R. Hobday, S.C. Lieutenant-Colonel J. Hill, R.E.	2″ = 1 mile for reduction to half scale.	Ditto, Rev.
15	Baluchistan	18	Colonel T. H. Holdich, R.E.	2″ = 1 mile, 1″ = 1 mile and ½″ = 1 mile for reproduction.	Ditto, Topo.
18	Himalayas	20	Major St. G. C. Gore, R.E. Captain J. M. Fleming, S.C. Captain W. J. Bythell, R.E.	4″ = 1 mile for reproduction and reduction to half scale and 2″ = 1 mile for reproduction.	Ditto, Trig.
Det.	Mergui	22	Mr. A. J. Gibson	1″ = 1 mile for reproduction.	Ditto, Rev.
Det.	Aden	24	Captain R. A. Wahab, R.E.	½″ = 1 mile for reproduction.	Ditto, Topo.
	Forest Surveys.				
14	Central Provinces	26	Colonel J. R. Wilmer, S.C.	4″ = 1 mile for reproduction.	Ditto, Trig.
17	Bombay	27	Colonel H. S. Hutchinson, S.C.	16″ = 1 mile, 8″ = 1 mile and 4″ = 1 mile for reproduction.	Ditto, Topo.
19	Madras	29	Lieutenant-Colonel J. R. McCullagh, R.E.	4″ = 1 mile for reproduction.	Ditto, ditto.
20	Lower Burma	31	Mr. A. D'Souza Captain J. M. Fleming, S.C.	4″ = 1 mile and 2″ = 1 mile for reproduction.	Ditto, ditto.
	Cadastral Surveys.				
2	Eastern Bengal	33	Mr. F. Grant „ W. J. O'Sullivan.	16″ = 1 mile and 2″ = 1 mile for reproduction.	Director, Bengal Surveys.
3	Upper Burma	37	Mr. G. B. Scott „ B. G. Gilbert-Cooper.	16″ = 1 mile and 1″ = 1 mile for reproduction.	D. S. G., Rev.
4	Western Duars	40	Captain G. B. Hodgson, S.C.	16″ = 1 mile, 4″ = 1 mile and 2″ = 1 mile for reproduction.	Director, Bengal Surveys.
6	Assam	45	Mr. E. C. Barrett.	16″ = 1 mile for reproduction.	D. S. G., Rev.
7	Lower Burma	48	Mr. C. Wood	16″=1 mile for reproduction.	D. S. G., Rev.
8	Orissa	51	Lieutenant-Colonel I. E. Sandeman, S.C. Lieutenant R. T. Crichton, S. C.	16″=1 mile for reproduction.	Director, Bengal Surveys.

Statement of Survey Operations and Parties—continued.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
12	Lower Burma	58	Mr. W. H. Patterson	16″=1 mile for reproduction.	D. S. G., Rev.
Det.	Garhwal	63	Mr. T. F. Freeman	32″=1 mile for reproduction.	Ditto, ditto.
Det.	Burdwan	66	Mr. T. Shaw	16″=1 mile for reproduction.	Director, Bengal Surveys.
	Traverse Surveys.				
9	Central Provinces	69	Mr. G. H. Cooke „ H. Dowman	16″=1 mile (skeleton plots).	D. S. G., Rev.
Det.	Bihar	71	Mr. J. S. Pemberton	16″=1 mile (skeleton plots).	Director, Bengal Surveys.
	Geodetic.				
22	India	74	Captain S.G. Burrard, R.E.	.....	D. S. G., Trig.
23	Ditto	*ib.*	Lieutenant G. P. Lennox-Conyngham, R.E.	.....	Ditto, ditto.
	Tidal and Levelling Operations.				
25	India	75	Lieutenant-Colonel J. Hill, R.E.	.....	Ditto, ditto.
	Geographical Surveys.				
11	Upper Burma	78	Captain H. M. Jackson, R.E. Colonel R. G. Woodthorpe, C.B., R.E.	½″=1 mile.	D. S. G, Topo.
21	Ditto	79	Captain F. B Longe, R.E. Captain T. F. B. Renny-Tailyour, R.E.	½″=1 mile.	Ditto, ditto.
Det.	Hazara border	81	Captain R. A. Wahab, R.E.	½″=1 mile.	Ditto, ditto.

OUT-TURN.

8. The total area that has been surveyed in detail during the year amounts to 80,101 square miles. In addition to this, the traverse operations carried on in the Central Provinces for the purpose of furnishing a basis for field surveys under the Settlement Department, and in Bihar in preparation for the cadastral survey by the Survey Department, embrace an area of 5,921 square miles. The following is a summary of the operations of the different field parties in the order in which they appear in the above statement. A detailed report of the work of each party for the year under review will be found in Part II.

TRIGONOMETRICAL SURVEYS.

9. The principal triangulation of Upper Burma was continued by one party along the meridian of 96° 30′, and no other principal series has been taken up during the year. Seven figures extending over a direct distance of 195 miles, and covering an area of 4,300 square miles, were completed. A secondary series emanating therefrom on the parallel of 21° north latitude, comprising six stations, at three of which observations were completed, was laid out for a distance of 96 miles eastward.

TOPOGRAPHICAL SURVEYS.

10. Three parties and two detachments have been employed on this class of operations during the year, one of the four parties so employed during last year, *viz.*, No. 13, having been reduced to a detachment. The three parties, Nos. 10, 15 and 18, have continued the topographical surveys on various scales in the Bombay Presidency, in Baluchistan and in the Himalayas, respectively, and the detachment of No. 13 Party extended its previous operations over the tin-bearing tracts in Mergui district, Lower Burma. The second detachment was specially organized to undertake the survey of the districts in the

neighbourhood of Aden, which was carried to a successful conclusion in the face of many physical and political difficulties.

11. Besides the work executed by the regular topographical parties, various small areas, principally of intervening tracts not required to be surveyed for revenue purposes, have been surveyed topographically by some of the cadastral parties, in order to complete the survey of the standard topographical maps or for other special purposes. In connection with the cadastral surveys in Upper Burma, a special survey, on the 1-inch scale, has been made of certain coal fields in the Upper Chindwin district by No. 3 Party, comprising an area of 106 square miles. A section of No. 4 Cadastral Party was employed on the survey, on the 2-inch scale, of the waste lands in the Jalpaiguri district in the parts where the cadastral survey was considered unnecessary: an area of 337 square miles was thus completed. Another detachment of the same party was engaged on the demarcation of the Jalpaiguri-Bhutan boundary, which has been re-laid and new marks have been put up, wherever practicable, each one of which is visible from the next. A survey on the 4-inch scale has been made of the boundary and of a strip of country on each side, by which the positions of the marks can be readily identified.

12. The areas topographically surveyed on various scales during the year amount to 9,909 square miles, as compared with 10,193 square miles in the previous year, the decrease being due to the smaller establishment engaged on this class of work.

The total area is made up as follows:—

5,279	square miles	surveyed	on the	½	-inch	scale.
871	"	"	"	1	"	"
3,446	"	"	"	2	"	"
270	"	"	"	4	"	"
15	"	"	"	6	"	"
28	"	"	"	8	"	"

FOREST SURVEYS.

13. The four parties engaged on forest survey operations last year in the Central Provinces, the Bombay and Madras Presidencies and in Lower Burma, have continued their previous operations during the year under review. Forest surveys were also carried on by the cadastral party working in the Western Duars, Bengal, and to a small extent by the Himalaya party in the Punjab.

14. In the Central Provinces, the surveys of all the forest reserves allotted for survey in districts Hoshangabad and Betul were completed during the year, and a considerable area was triangulated in advance in district Nimar for next season's detail work. The classification of forest growths and soils of the entire area was also completed. The season was exceptionally unhealthy, but nevertheless the out-turn, *viz.*, 483 square miles, exceeds that of the previous season by 22 square miles.

15. In the Bombay Presidency, the party continued the survey of the forest tracts in the northern and southern forest circles. The work done comprises surveys on the 16-inch scale in Poona and Sholapur districts, on the 8-inch scale in the Thana and Kolaba districts, and on the 4-inch scale in the Kanara district. In addition, an elaborate survey on the 8-inch scale was made of the Singhar hill, near Poona, to furnish an accurate map for purposes of instruction in forestry. The aggregate out-turn amounts to 437 square miles, which is less than that of the preceding season by 102 square miles: this is partly attributable to a severe outbreak of fever among the establishment, which caused considerable delay at the beginning of the season, and to a larger amount of preliminary triangulation having been done in advance for future detail work.

16. In the Madras Presidency, forest survey operations on the 4-inch scale were continued in the Madura district, and commenced in the Coimbatore district; while a small area left unsurveyed in the previous season in the Tinnevelly district was completed. The out-turn comprises an area of 659 square miles, which is the largest yet accomplished by this party, and exceeds that of last year by 194 square miles, which is very satisfactory. The cost-rate of the survey has been further decreased, the mileage-rate for the year being R97-6.

17. In Lower Burma, the party continued the survey of the forest reserves in the Toungoo district on the 4-inch scale, the intervening unreserved tracts being surveyed on the 2-inch scale. The total out-turn comprises 294 square miles, which is less than that of last year by 77 square miles, but the decrease is counterbalanced by the 4-inch area done this year being much larger than that of last year. The difficulties of the country under survey are exceptionally great.

18. A detachment from the cadastral party, No. 4, employed in the Western Duars, Bengal, completed the survey, on the 4-inch scale, of the reserved forests in the Jalpaiguri district, amounting to an area of 327 square miles. The party working in the Himalayas completed the survey of 45 square miles of forest reserves in the Simla Hill States.

19. The total out-turn of forest surveys executed on the various scales amounts to 2,245 square miles, as compared with 1,841 square miles surveyed by the same parties last year. The areas on the different scales are as follows:—

68	square miles surveyed	on	the	2-inch	scale.	
1,935	"	"	"	4	"	"
202	"	"	"	8	"	"
40	"	"	"	16	"	"

CADASTRAL SURVEYS.

20. The number of parties engaged on cadastral operations during the year has been as follows:—Three parties (one of double strength) and one detachment in Bengal; three parties in Burma; one party in Assam; and a detachment in the North-Western Provinces.

21. In Bengal, the three parties were employed in the Western Duars, in Chittagong and in Orissa, and the detachment in Burdwan. The cadastral survey of the cultivated portions in the Jalpaiguri district of the Western Duars was for the most part completed in the previous year, an area of only 23 square miles being left, which was finished this year. The principal work of the section employed on the cadastral operations has been the completion of the records, which occupied it throughout the season. The bulk of the party was employed on topographical work in the reserved forests and waste lands, and the demarcation of the Bhutan boundary, which have been referred to under previous heads. The survey of the district is now completed: the difficulties and obstructions met with were exceptionally great, and prolonged the operations over four seasons. The extreme unhealthiness of the climate and the consequent difficulty of getting efficient *amins* and sub-surveyors to take service there, the very scattered nature of the work, as well as the large amount of jungle met with interspersed with the cultivation, have all tended to hinder the progress of the work, and have largely enhanced the cost of the operations. The total area cadastrally surveyed in the Jalpaiguri district is 782 square miles, and its cost, including the preparation of the record of rights, has amounted to R3,69,801, which gives the high rate of 11½ annas per acre.

22. In Chittagong, the cadastral operations were continued. The original programme was to complete the survey in the Sadar sub-division, but by orders received in October, 1891, the operations were extended to Cox's Bazar. The area of cadastral survey completed on the 16-inch scale comprises 459 square miles in the Sadar sub-division and 26 square miles in Cox's Bazar. An additional area of 3 square miles was surveyed within the Municipality of Chittagong, partly on the 16-inch and partly on the 32-inch scale. The boundaries of tea gardens were also surveyed on the 16-inch scale, but in skeleton only, the interior details being omitted: the out-turn of this skeleton boundary survey is 187 square miles. Cholera was raging all over the area under survey during the latter months of the season, and there were 93 casualties therefrom in the establishment which however remained at its work with commendable zeal.

A cadastral survey of the Chakla Roshnabad estate in Tippera, belonging to the Maharaja of Hill Tippera, was decided on late in the season, and a detachment from the Chittagong party commenced the traverse survey thereof in April, and with considerable difficulty completed an area of 105 square miles. Preparations have been made for the coming cadastral survey by training 200 local men, and 100 more were under instruction at the close of the season.

23. In Orissa, the survey operations were continued in the Puri and Cuttack districts and commenced in the Balasore district. With a view to accelerating the progress and decreasing the cost-rate of the work, the strength of the party was greatly increased, and when it took the field it was equivalent to two ordinary cadastral parties. The area cadastrally surveyed on the 16-inch scale amounted to 1,402 square miles. In addition to this, the revision of 364 square miles of the Irrigation survey of 1878-79 on the 32-mile scale was effected and the maps brought up to date, a task which proved to be very little less arduous than making a survey *de novo*. Uriyahs have been only partially employed on the survey, as their progress was extremely slow: the average amount of work done by the Uriyah *amin* was only one-fifth of that done by the upcountry *amin;* their services were therefore utilized for the *khanapuri*. In the areas cadastrally surveyed, the record writing of 3,075 villages, covering an area of 1,452 square miles, was accomplished: this includes the records of the revised survey area which had not previously been written. The difficulties experienced in *khanapuri* has been very great during this season: the slow progress of the Uriyah *amin*, the constant changes in procedure, the non-supply of the *khewats*, and the inexperience of some of the *khanapuri* officers supplied by the Settlement Officer, interfered greatly with progress. The large amount of work which has been accomplished under such circumstances is very creditable to Lieutenant-Colonel Sandeman, who held executive charge of the party till the end of January, and to Lieutenant Crichton, who succeeded him.

The result of increasing the strength of the establishment has been the reduction of the cost-rate per square mile from ₹179 in the previous season to ₹157 in the present one, or a saving of ₹22 per square mile. The present year's rate is inclusive of the cost of completing considerable arrears of the work of the former year, and it is anticipated that the mileage-rate will be still further reduced during the ensuing season.

24. The survey of the estates of the Maharaja of Burdwan, situated principally in the Bankura district, was resumed by the small detachment which has been employed on this work for the last three years, in consequence of the manager having been able to recover possession of some missing villages from the light thrown on them by the survey of previous seasons. The difficulties experienced in this survey have been of an extraordinary nature: owing to the inaccuracy of the list of *patnidars* furnished by the Raj, it was found impossible to ascertain who were the real tenants, and therefore their attendance could not be enforced; the necessary information required to identify all the lost villages which by years of mismanagement had been lost sight of could not therefore be obtained. Operations were moreover obstructed by the deliberate uprooting of survey marks by the *patnidars*. The actual area surveyed cadastrally was only 13½ square miles out of 62½ square miles which the Raj officials claimed but were unable to point out. In addition to this, 621 square miles have been traversed.

25. Of the three parties engaged on cadastral surveys in Burma, one was employed in Lower Burma and two in Upper Burma. In the former, an area of 1,010 square miles were surveyed on the 16-inch scale in the districts of Amherst, Tavoy and Mergui; and in addition to this, 106 square miles of hilly country intervening between the cadastral portions were mapped on the 2-inch scale. The extent of the country to be surveyed, both in Tavoy and in Mergui, proved to be very much greater than had been anticipated, and it was found impossible to complete the required areas in these two districts in one year, as had been hoped. There were 54 Burmans employed as field surveyors during this year, the same number as in the previous year. The average out-turn of the Burman surveyor has again been found to be four-sevenths of that of the Hindustani *amin*, which agrees with the results of last year, and the loss on this account has been calculated at ₹100 for each Burman employed per season, after allowing for the cost of the passage to and from India for the Hindustani *amin*.

26. In Upper Burma, one party (No. 3) completed the cadastral survey of 1,818 square miles, on the 16-inch scale, in the Sagaing district, and commenced traverse operations in the Shwebo district, where 800 square miles were traversed in advance. At page 88 will be found a table in which are given cost-rates and other particulars of cadastral surveys completed since 1890-91.

The districts of Kyaukse, Mandalay, and Meiktila were surveyed by this party. It is satisfactory to see how greatly the cost-rate per square mile has been reduced since the first year of the operations in Upper Burma. During the first year the rate in Kyaukse was ₹227 per square mile, and this has now been reduced to ₹103 in Sagaing; it should however be noted that the difficulties in Kyaukse, owing to the lands having been to a great extent flooded, were much greater than in any of the other districts. The reduction in the cost-rate is largely due to the partial employment of local labour for chaining purposes in place of *khalâsis* imported from India, which has been found practicable in Upper Burma. Thirty-six Burmans were employed this year on the field survey against 30 during the previous year. With regard to the larger employment of Burmans as surveyors, the officer in charge reports that they are so uncertain that complete reliance cannot be placed on them.

27. The second party working in Upper Burma was employed in the Minbu district. This was the first season's cadastral work of this party, it having been for the last two years occupied in traverse operations in Lower Burma. In the Minbu district, 784 square miles of cadastral survey and 1,288 square miles of traverse survey were completed; a small amount, *viz.*, 156 square miles, was also traversed in the adjoining district of Magwe for next season's cadastral survey. Of the area cadastrally surveyed, 673 square miles were executed by Hindustani *amins* and 111 square miles by Burmans. Here, again, it was proved that though the work of the Burman may, so far as quality is concerned, compare well with that of the Hindustani, he is a slower, and consequently a more expensive, agent. A certain amount of local labour was also utilised in this party.

28. In Assam, cadastral operations were completed in the districts of Kamrup, Darrang, Sibsagar, and Lakhimpur in the Assam valley and continued in Sylhet. The detail surveys were made by a mixed establishment, in which the local agency largely preponderated: to the Hindustanis were allotted, as a rule, the more difficult portions, owing to their being better skilled than the locally trained men; to each Hindustani *amin* was attached a deputy *mandal* to write the Bengali records. The out-turn consists of 756 square miles of 16-inch survey in the Assam valley and 72 square miles in Sylhet. Extraordinarily heavy rains set in towards the end of March and almost paralysed all field operations; it was not until the 15th May that work was fairly resumed. The field season was less unhealthy than usual.

29. In the North-Western Provinces, the party which had hitherto been employed there for many years was partly transferred to Bengal, and a detachment only retained to continue the survey operations in the Garhwal district. The scale of the cadastral survey is 32 inches = 1 mile, the small size of the field necessitating the adoption of this large scale. Arrangements had been made for training a number of hill *amins* in anticipation of the non-return of many of the *amins* from the plains in consequence of the inconveniences they had to put up with from the physical difficulties of the country and the inclemency of the climate: this expectation was realized, for not half the old staff of *amins* returned. The area surveyed amounts to 232 square miles; it includes small patches of intervening waste, and it is estimated that at least 157 square miles will be classified as assessable land, in which at the time of last settlement only 65½ square miles were assessed. The cost-rate of the detail survey was only ₹183 per square mile, as against ₹283 last year. This reduction is chiefly due to the increased rate of progress made by the *amins* and to the reduced pay granted to the menials. The traverse operations were completed over all the tracts assigned for survey.

30. The areas of cadastral survey completed during the year in the different provinces are as follows:—

	Square miles.
Bengal	1,926
Burma	3,612
Assam	828
North-Western Provinces	232
TOTAL	6,598

This shows an increase of 1,565 square miles of cadastral survey over the out-turn accomplished in 1890-91, when there were 7 parties and 1 detachment

employed; during this year there have been 7 parties (one being double) and 2 detachments at work. In addition to the above out-turn, 187 square miles of skeleton boundary survey, on the 16-inch scale, was executed in district Chittagong, and 364 square miles of revision survey in district Cuttack, which, as before stated, involved almost as much labour as a new survey.

TRAVERSE SURVEYS.

31. This year one party and one detachment were engaged on traverse operations: the first in the Central Provinces in continuation of previous operations, to furnish skeleton plots on an accurate basis for the field surveys to be executed by village *patwaris* and other local agency under the Settlement Department; the second in Bihar in preparation for the cadastral survey to be commenced by the Survey Department in October 1892.

32. The out-turn of work in the Central Provinces amounted to 4,311 square miles, of which 2,174 square miles were in the Mandla district, 1,215 in Balaghat, and 922 in Bhandara. The country was for the most part hilly and densely wooded, the cultivation being scattered and difficult of approach on account of the intervening stretches of hill and forest. Skeleton plots, on the 16-inch scale, of 1,171 villages have been transmitted to the Settlement Department. The party suffered considerably from the malarious nature of the climate until about the end of February; influenza also prevailed throughout all the districts under survey, no less than 27 men dying of it.

33. In Bihar, a total area of 1,610 square miles has been completed, of which 1,247 are in the Muzaffarpur district and 363 in Champaran. In addition to this, there is a balance of 301 square miles of traverse survey left over from the experimental survey executed under Colonel Barron in 1885-86, which gives an area of 1,911 square miles ready to commence cadastral work in October 1892. Stone marks two feet long have been embedded at tri-junctions and at the adjoining stations on each side; the rest of the traverse stations have been marked by pottery cylinders locally made.

34. The areas which have been traversed during the year are as follows:—

	Square miles.
Central Provinces	4,311
Bihar	1,610
TOTAL .	5,921

This out-turn is 1,328 square miles in excess of that accomplished in the previous year by two full parties.

SPECIAL OPERATIONS.

35. The electro-telegraphic determinations of differences of longitude were resumed this year and six arcs were measured, *viz.*, Waltair-Madras, Waltair-Bolarum, Waltair-Jubbulpore, Calcutta-Waltair, Bolarum-Bombay, and Fyzabad-Dehra, thus completing the scheme of differential longitude determination within India proper. There remains some more work of this description to be done in Burma, Baluchistan, and Persia at some future date, but it has been postponed for the present in favour of other more pressing wants. The final reduction has also been completed, and will probably appear in Vol. XV of the professional series in the spring of 1893.

36. The tidal operations have been continued as usual. Observations with the self-registering tide-gauges have been made at 14 stations in India, Burma, Ceylon, the Andaman Islands and Minicoy. Two observatories have been dismantled during the year under report on completion of the necessary registrations, and four new ones are in course of erection.

37. In connection with these operations, spirit-levelling operations have been also continued and 452 miles of levelling were run, chiefly along the Bengal-Nagpur Railway, eastwards of Bilaspur.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

38. The area geographically surveyed during the year is considerably less than that which was obtained during the past two seasons, owing to the circumstance that no opportunity offered for explorations in Persia this year, which in the two previous years added large areas to the out-turn. The sphere of unknown country within our eastern and western borders is now considerably contracted, and the main part of this year's operations have been confined to the more regular surveys. Large areas of new country have however been mapped in Burma and Southern Baluchistan again this year.

39. The two parties, Nos. 11 and 21, employed in Upper Burma, have continued the preliminary survey of the country on the $\frac{1}{4}$-inch scale, which has now been brought within measurable distance of completion, except in the extreme northern part of the province, where the country is not sufficiently settled for survey operations, and which can only be accomplished in connection with military expeditions. In addition to the regular survey by districts, surveyors were as usual detailed to accompany the military and police expeditions proceeding into new country. The officers in charge of the parties were chiefly engaged in triangulation and in the general supervision of the regular work; but Captain Jackson, R.E., in charge of No. 11 Party, found time to explore the Bret country lying to the south-west of Karenni and to draw up a report on the country traversed and its inhabitants.

40. Mr. Kennedy accompanied the Maingkwan column under Major Dalzell, the object of which was to explore the Hukong valley. He joined the expedition at Mogaung in November 1891, whence it proceeded in a north-westerly direction to Laban and across the watershed, *vid* Sadusot, to Maingkwan in the Hukong valley. From this place he was able to secure a considerable area of new topography during excursions made to important surrounding villages. He returned to Mogaung in February by the Chindwin route, passing through the Taro valley. During the expedition, Mr. Kennedy succeeded in obtaining an area of 3,750 square miles of new country.

41. The total areas mapped by the two parties in Upper Burma amount to 42,078 square miles.

42. In addition to the regular topographical surveys executed by No. 15 Party in Baluchistan, a detachment was employed on geographical surveys in Kolwah and Makrán, and brought in an area of 19,084 square miles of previously unexplored country, mapped on the $\frac{1}{4}$-inch scale.

43. The military expedition under Sir William Lockhart, K.C.B., which operated against the Isazai tribes in the Indus valley in October, 1892, was accompanied by a small survey party under Captain Wahab, R.E. The brief time occupied by the expedition did not admit of much survey work being done, but Captain Wahab was able to reconnoitre an area of about 250 square miles on the $\frac{1}{2}$-inch scale in the Chamla and Buner valleys. This area has been included in the out-turn given under the head of topographical surveys.

44. Captain Bower, in his adventurous journey through Tibet during 1891-92, was accompanied by Atma Ram, an employé of the Survey Department, who was utilized for keeping the record of the route traversed. He succeeded in maintaining an unbroken traverse of over 2,000 miles in length, extending over 24 degrees of longitude. His services while employed on this duty, which was voluntarily undertaken, have been warmly commended.

45. The aggregate areas geographically surveyed during the year amount to 61,162 square miles, mapped on the $\frac{1}{4}$-inch scale.

HEAD-QUARTERS OFFICES.

46. The work done in the various offices at head-quarters is described in detail in Part III of this report.

47. The cartographic and other offices at the head-quarters have been superintended, as usual, by three Assistant Surveyor-Generals, *viz.*, the Drawing and Engraving Offices by Colonel W. H. Wilkins, S.C., except for a period of about six weeks when Colonel J. R. Wilmer, S.C., acted in charge; the Photographic and Lithographic Office by Colonel J. Waterhouse, S.C.; and the

Correspondence and Mathematical Instrument Offices by Lieutenant-Colonel M. W. Rogers, R.E., except for a period of seven weeks when Colonel W. H. Wilkins, S.C., acted.

48. In the Drawing Branch the maps of Burma on various scales have again formed the principal work. The second edition of the general map of Burma, on the 32-mile scale, has been published in a preliminary form, pending the final settlement of some of the district boundaries. The new map of Upper Burma, on the 16-mile scale, has been almost completed and will be published by June 1893. The third edition of the 32-mile map of India is ready for printing, but the publication is delayed for want of orders from Government regarding the boundaries.

There has been a steady increase of work as in former years, but now that an additional establishment of 16 draftsmen has been sanctioned, there are hopes that, when they have been efficiently trained, the Drawing Office will be able to cope in a satisfactory manner with these yearly increasing demands.

49. In the Engraving Office, the new plates of the 32-mile map of India, with the borders extended to the east and west, so as to include the limits of Burma and Baluchistan, are in a forward state of progress and will be ready before the end of 1893. The various provincial maps on the 16-mile scale have been still further advanced. The duplicate plates of the 96-mile map of India and the 96-mile railway map of India for the administration report of the Railway Department have been completed. The maps of India on the 128-mile and 256-mile scales are still in progress.

50. In the Calcutta City Survey Office, the final examination and completion of the fair sheets have now been taken in hand and 12 have been sent to press. One block, No. XII, has been sent to the Municipal Office to be placed on view for two months before final publication, and this procedure, which is in accordance with the Act, will be adopted for the remaining blocks. Only 864 holdings were left for final demarcation at the close of the year under report, and these will be completed by the end of February 1893. Progress is being made with the preparation of the fair sheets on the 16-inch scale by the process of heliogravure.

51. The work done in the Photographic and Lithographic Office again shows a large increase, chiefly in the printing sections, and it has been exceedingly difficult to comply with all the demands for colour printing, even with the aid of the steam machinery. An additional quad-crown steam litho-press has been obtained and is being put up, which will, it is hoped, enable the office to keep abreast of the increasing demands upon it. Out of a total of 7,532 original maps received for reproduction during the year, 4,956 were cadastral maps, 1,152 were ordinary departmental maps, etc., and 1,424 were miscellaneous subjects for other departments. The printed out-turn of extra-departmental work was again considerably in excess of the ordinary departmental work, and the value of it was R72,677-12. The number of pulls of maps and various other subjects printed off was 756,068; besides which there were 1,318,597 impressions from type, 92,415 heliogravure prints, and 5,464 photographic prints. The total value of the work done was about R2,10,357, being R 1,703 more than that of last year and R9,982 greater than in the year before it.

52. Maps of districts Shahabad, Sylhet, and Patna have been lithographed by transfer from the copper plates, and several others of the same series prepared. A panoramic view of the snowy range, as seen from Simla, was drawn on stone from Colonel Woodthorpe's original drawing, but has not yet been printed off. The additions and corrections on stone to the 32-mile map of India (3rd edition) have again occupied much of the time of the lithographic section, and the publication of the map is awaiting the orders of the Government in regard to the boundaries.

53. Among the departmental maps photo-zincographed and published may be noticed maps of districts Benares and Basti, on the scale of 1 inch = 2 miles, prepared for the North-Western Provinces Government, plans of the stations of Dinapore, Kampti and Satara, and divisional maps of Kumaun, Rohilkhand, and Gorakhpur. Ninety-nine standard sheets of the topographical and revenue surveys were published either as new maps or re-prints with corrections and additions; and thirty sheets of the Madras forest surveys have also been published. A commencement has been made of the work of reproducing the original

sheets of the Calcutta survey on the scale of 50 feet = 1 inch, but no sheets have yet been printed. The preparation of the reduced map on the scale of ·330 feet to the inch noticed in last year's report has not made progress, as the system proposed for preparing the reduced maps was not found to answer; but further experiments are being made.

54. Although the number of extra-departmental subjects received for reproduction was somewhat less than last year, the number of printed impressions shows a further large advance, owing to the increased demands for colour printing. The ordinary demands upon the office have been swelled by the preparation and supply of the maps and diagrams illustrating the report of the Leprosy Commission and the Census Reports for Assam, Rajputana, Central India Agency, and Berar. The preparation of these maps, as well as the increasing requirements of the meteorological departments for weather charts and diagrams in colour, have been a heavy tax on the resources of the office. The work done for other departments also includes the following: a new and elaborately coloured geological map of India for the Geological Survey Department; maps illustrating the gauges and systems of railways and an unusually large number of diagrams for the Railway Department; a series of colonial emigration maps; a coal and iron map; the administration report maps for Bengal and the Punjab, which have largely increased in their scope in recent years; a large number of maps, etc., many of them in two colours, for the Quarter Master General's Department; and a series of 8 plates of native soldiers illustrating the records of the Bengal Army.

55. Good progress has been made in the heliogravure section, though the number of plates photo-etched is somewhat less, owing to the introduction of photo-blocks. Fifty plates were reproduced by photo-etching, including 12 plates of Fishes and Crustacea for the illustration of Dr. Alcock's report on "The Zoology of H. M.'s. I. M. S. "Investigator," 13 plates of the Bower manuscript, and 8 plates of the Technical Art Series. Fifty-seven photo-blocks were prepared, most of them being for the illustration of Mr. Cotes' notes on Economic Entomology published by the Trustees of the Indian Museum. Fourteen hand engraved plates have also been electrotyped for the Engraving Office.

56. Colonel Waterhouse reports on a method of preparing a very sensitive orthochromatic collodio-bromide emulsion he has had under trial. Plates with the new emulsion require to be used in a moist state in order to obtain the greatest sensitiveness and clearness in the results; but this has inconveniences, and if some means could be found of preparing dry plates in this way with almost equal sensitiveness, the process might be introduced with considerable advantage. Trials have been made of new developers for dry plates, but the increased pressure of office work has left but little time for experiment in this or other new directions.

57. The number of new maps and new editions of departmental subjects published during the year amounted to 5,103, of which 4,897 were cadastral maps. The total number of maps issued was 190,579 and their value ₹ 1,36,079, which is somewhat less than the corresponding figures of last year. The cash sales of maps amounted to ₹22,091 during the year against ₹12,917 in the previous year. The increase under this head is principally due to the introduction of the ruling that public departments have to pay in cash for supplies under the value of ₹50—a procedure which involves considerable extra clerical labour and responsibility.

58. The demands on the Mathematical Instrument Office for scientific instruments are again in excess of last year, the total number of instruments issued on 1,500 indents being 83,202, valued at ₹3,16,373, as compared with 64,203 instruments, valued at ₹2,88,337, issued during the previous year. This has not been the result of any particularly heavy demand from any one department but of a general increase of demands throughout.

During the year 93,661 serviceable instruments, valued at ₹ 3,85,697, and 5912 repairable instruments, valued at ₹75,365, have been received into store. Owing to the partial introduction of cash payments for supplies under the value of ₹50, the cash receipts have increased from ₹14,871 in the previous year to ₹23,137 in the present year.

59. In the Trigonometrical Branch Office, Dehra Dun, the computing section has made considerable progress with Volume XV of the "Account of the Operations of the Great Trigonometrical Survey of India," containing the results of the electro-telegraphic differences of longitude, as well as the final reduction of all the longitude materials collected up to date: this volume will, it is expected, be published in the spring of 1893. Progress has also been made with the volume containing the tidal observations and with the synoptical volumes of the several chains of principal triangles. Of the latter, five of the Southern Trigon and five of the South-West Quadrilateral were occupying special attention. The pamphlet of spirit-levelled heights, No. 6, Bombay Presidency, was also published. Photographs of the sun were, as usual, taken on all days when it was visible, and the negatives forwarded to the Solar Physics Committee at South Kensington.

60. In the Drawing Office at Simla, the principal work of the year has been the preparation of the sheets of the South-West Asia series (comprising Western Persia) and of the North-West Trans-Frontier series, on the 8-mile scale. The first edition of the former series was completed. The North-West Trans-Frontier series is about half complete, and the publication of the sheets is progressing satisfactorily. The revision of the Turkestan map has made considerable progress during the year, and it is hoped that the new edition will be ready at an early date. Among other miscellaneous work done may be mentioned the compilation of Captain Bower's route traverse through Tibet, which was practically carried out in the field by Atma Ram, an employé of this office, who accompanied Captain Bower on his journey.

ESTABLISHMENT.

61. During the year, the Department has lost the services of five officers, of the senior division, who have been connected with it for many years.

Mr. W. H. Cole, M.A., Superintendent, 2nd grade, retired on the 7th April 1892, after a service of 25 years, during the whole of which time he was employed in the Trigonometrical Branch. Mr. Cole was an officer of high mathematical attainments, and his services have been of great value, especially in the preparation and publication of the scientific records of the Department.

Colonel R. Beavan, S.C., Deputy Superintendent, 1st grade, retired on the 11th June 1892, after a service of nearly 24 years in the Revenue and Topographical Branches.

Mr. A. D'Souza, Deputy Superintendent, 2nd grade, was superannuated on the 13th August 1892, after a service of 36 years, principally in the Topographical Branch. He was appointed originally in the junior division, and was promoted to the senior division in 1884.

Mr. M. J. Ogle, Assistant Superintendent, 1st grade, died while on furlough in England on the 4th April 1892, after a service of nearly 29 years in the Topographical Branch. The greater part of his service was rendered on the North-East frontier, where he gained a high reputation as an intrepid explorer. He was appointed originally to the Department in the junior division, and was promoted for his services to the senior division in 1890.

Mr. F. Grant, Assistant Superintendent, 1st grade, retired owing to ill-health on the 12th October 1892, after a service of 36 years, the whole of which was spent in the Revenue Branch. Mr. Grant was originally appointed to the junior division, and was promoted to the senior division in 1889.

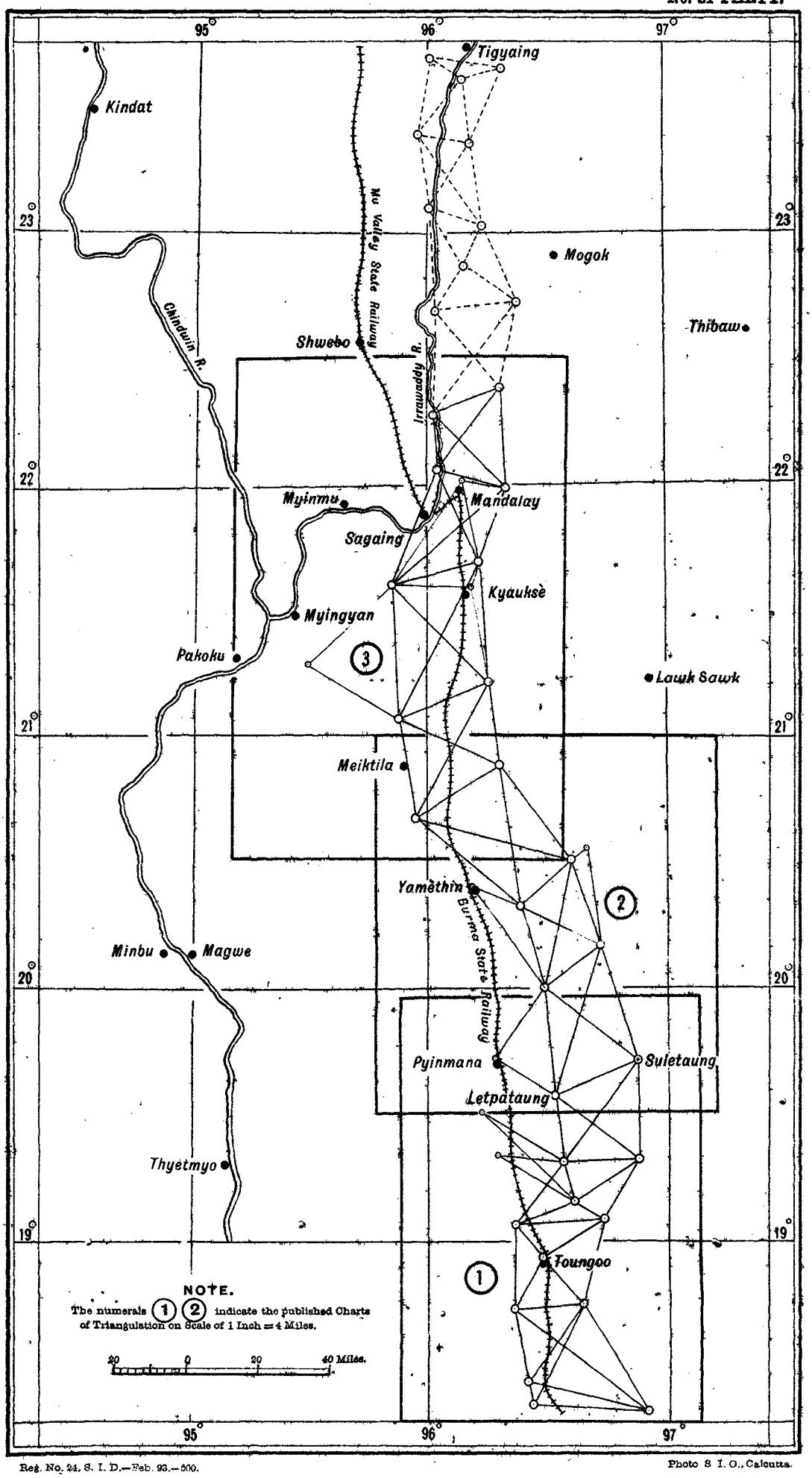
62. During the year, the sanction of the Government of India was obtained, merely for departmental convenience, to an alteration in the designations of officers of the junior division, the object of which was to bring them more into accord with the duties now performed by them, as well as into harmony with the present titles in other allied or similar departments. The designation of Surveyor, as applied to members of the lower controlling staff, was considered to be inappropriate and calculated to lead to misconception and inconvenience; the titles of Surveyor and Assistant Surveyor have accordingly been changed to Extra Assistant Superintendent and Sub-Assistant Superintendent respectively. At the same time the Government has been pleased to concede the rank of gazetted officers to Extra Assistant Superintendents in consideration of the fact

that the duties now performed by officers in these grades are of a more onerous and responsible nature than they formerly were, and in conformity with the status held by the officers of the subordinate executive service with whom they are brought into official dealings under the new system of survey-cum-settlement procedure.

63. In the junior division seven vacancies occurred—two by the deaths of Messrs. G. A. McGill and J. Newland, one by the retirement of Mr. D. Atkinson, superannuated, one by the promotion of Mr. J. S. Pemberton to the senior division, and three by the deputation of officers to the Land Records Department in Burma.

INDEX TO THE CHARTS OF THE PRINCIPAL TRIANGULATION OF THE MANDALAY SERIES, BURMA.

No. 24 PARTY.



Reg. No. 24. S. I. D.—Feb. 93.—300.

Photo S. I. O., Calcutta.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

PRINCIPAL TRIANGULATION.

BURMA.

No. 24 Party.

64. This party, under Lieutenant Close, continued the principal triangulation in Upper Burma northward from the side Letpataung—Suletaung, up to which it had been carried in the previous season. For two figures, the direction of the series was nearly due north. It was then diverted slightly west of the original adopted meridian of 96° 30′, in order to avoid some difficult country, and to bring the west flank on to the plains, where the stations are most needed. The two southern figures were entirely in the hills which border the Southern Shan States: the remaining stations were partly on the same hills and partly on lower ones in the plains. The principal triangulation was carried through the districts Pyinmana, Yamethin, Meiktila, Kyaukse and Mandalay. A detachment of the party, under Mr. Christie, made a commencement with a secondary series, starting from the base Lethataung—Sintaung, and going eastwards through Mone towards the Mekong river.

Personnel.

Lieutenant C. F. Close, R.E., Deputy Superintendent, 2nd grade, in charge.
Lieutenant J. M. Burn, R.E., Assistant Superintendent, 1st grade.
Mr. A. Christie, Extra Assistant Superintendent, 2nd grade.
„ T. H. Rendell, Extra Assistant Superintendent, 3rd grade.
„ J. Hickie, Extra Assistant Superintendent, 4th grade.

65. The assistants arrived at Pyinmana on the 30th October, 1891, and Messrs. Rendell and Hickie completed the selection of a figure that the haze had rendered doubtful at the end of the previous season. Lieutenants Close and Burn arrived on the 13th November. The distribution of work was as follows: Lieutenant Close to undertake the observations of the four northern figures, and Lieutenant Burn those of the three southern ones; Mr. Christie to commence the secondary series, while Messrs. Rendell and Hickie were detailed to select and build forward stations north of Mandalay on the west and east flanks respectively. The principal observations were commenced by Lieutenants Close and Burn in the middle of November, and were continued till the 14th February 1892.

66. Cloud and rain hindered the work at the beginning of the season, and the haze set in unusually early. When the haze interrupted the terrestrial observations, astronomical observations were taken for azimuth. The work on the approximate series was continued till the 21st March 1892, and the building of covering pillars till the 14th April, when the field operations were closed.

67. With a view of comparing the heights obtained by the trigonometrical survey with those by the railway, levels were taken from a railway bench-mark at Mandalay to the trigonometrical survey station there, and from a trigonometrical survey bench-mark at Rangoon to a railway bench-mark there. The result gives a difference of 21 feet in the height of Mandalay hill station, the trigonometrical value being 783 feet and the railway value 762 feet above sea-level.

It is intended during the current season to run a line of levels from Rangoon to Mandalay, with necessary subsidiary lines, to the trigonometrical survey stations. This, besides checking the trigonometrical heights, will furnish a series of bench-marks for reference in irrigation and other projects of the Public Works Department, which it has been ascertained will be of the greatest utility.

68. In the recess, the computation of the principal triangulation and the drawing of the charts were finished. It is interesting to compare the resulting

latitudes and longitudes with those of the same hill stations used by the topographical survey party. These latter were based on a value of Mandalay Palace station obtained by Major Hobday on the first occupation of Upper Burma, the latitude being obtained from astronomical observations with a 14-inch vernier theodolite, and the longitude by frequent comparisons of the 4 P.M. Madras telegraphic time signal with the local time. The error in latitude was 3″·5 and in longitude 1″·2 of arc, which are remarkably small quantities.

69. The result of the season's outturn is as follows: Horizontal and vertical angles have been taken at fifteen principal stations, and star observations for determination of azimuth were taken at three stations. The series was extended over a direct distance of 195 miles, embracing an area of 4,300 square miles. Ten stations were selected and built in advance of the completed principal work, extending to a point 30 miles south of Katha. Seven important points were fixed by intersection, and seven covering pillars were built over principal stations. Six stations of the Kyaingsen secondary series were selected and marked, and six angles of that series observed.

70. The principal triangulation has been adjusted in seven figures, all quadrilaterals. The observations were made with Troughton and Simms' 12-inch microscope theodolites Nos. 1 and 2, and the mean triangular error for the whole season was 0″·62.

71. A statement giving the details of the outturn executed during the year will be found at page i of the appendix.

72. The party left Mandalay for recess quarters at Mussoorie on dates varying between April 15th and May 5th, 1892, Lieutenant Close leaving on the latter date. During recess, the party was working in the office of the Deputy Surveyor-General, Trigonometrical Branch, who thus had frequent opportunities of inspecting the work, concerning which he reports very favourably.*

TOPOGRAPHICAL SURVEYS.

GUJARAT AND SOUTHERN MARATHA COUNTRY.

No. 10 Party.

73. This party continued the detail survey in Gujarat and the Southern Maratha country, on the scale of 2 inches = 1 mile. Field operations commenced about the 15th November, 1891, and closed in Gujarat about the 15th May, 1892, and in the Southern Maratha country about the 1st June, 1892. Messrs. Todd and Stotesbury conducted the work in Gujarat, and Mr. Tapsell that in the Southern Maratha country, whilst Mr. Dickenson carried on the triangulation in advance for next field season's detail survey.

Personnel.

Lieutenant-Colonel J. Hill, R.E., Superintendent, 2nd grade, in charge up to 19th October, 1891, and from 1st to 12th November, 1891.
Colonel H. S. Hutchinson, S.C., Superintendent, 2nd grade, in charge from 13th November up to 4th December, 1891.
Major J. R. Hobday, S.C., Deputy Superintendent, 1st grade, in charge from 20th to 31st October, 1891, and from 5th December, 1891.
Lieutenant H. A. D. Fraser, R.E., Assistant Superintendent, 2nd grade, from 20th October, 1891.
Mr. W. Todd, Extra Assistant Superintendent, 1st grade.
„ W. Stotesbury, ditto ditto, 3rd „
„ C. Tapsell, ditto ditto, 4th „
„ W. M. Kelly, Sub-Assistant Superintendent, 1st „
„ R. R. Dickenson, ditto ditto, 1st „
„ J. A. Freeman, ditto ditto, 3rd „ from 23rd November, 1891.
24 surveyors, sub-surveyors and others.

74. The total outturn of the season's work is as follows:—

Detail survey, 2-inch scale	. . . . .	2,522 square miles.
Ditto 8 „ „	. . . . .	12 „ „
Triangulation	. . . . .	2,110 „ „
Traversing	. . . . .	642 linear miles.

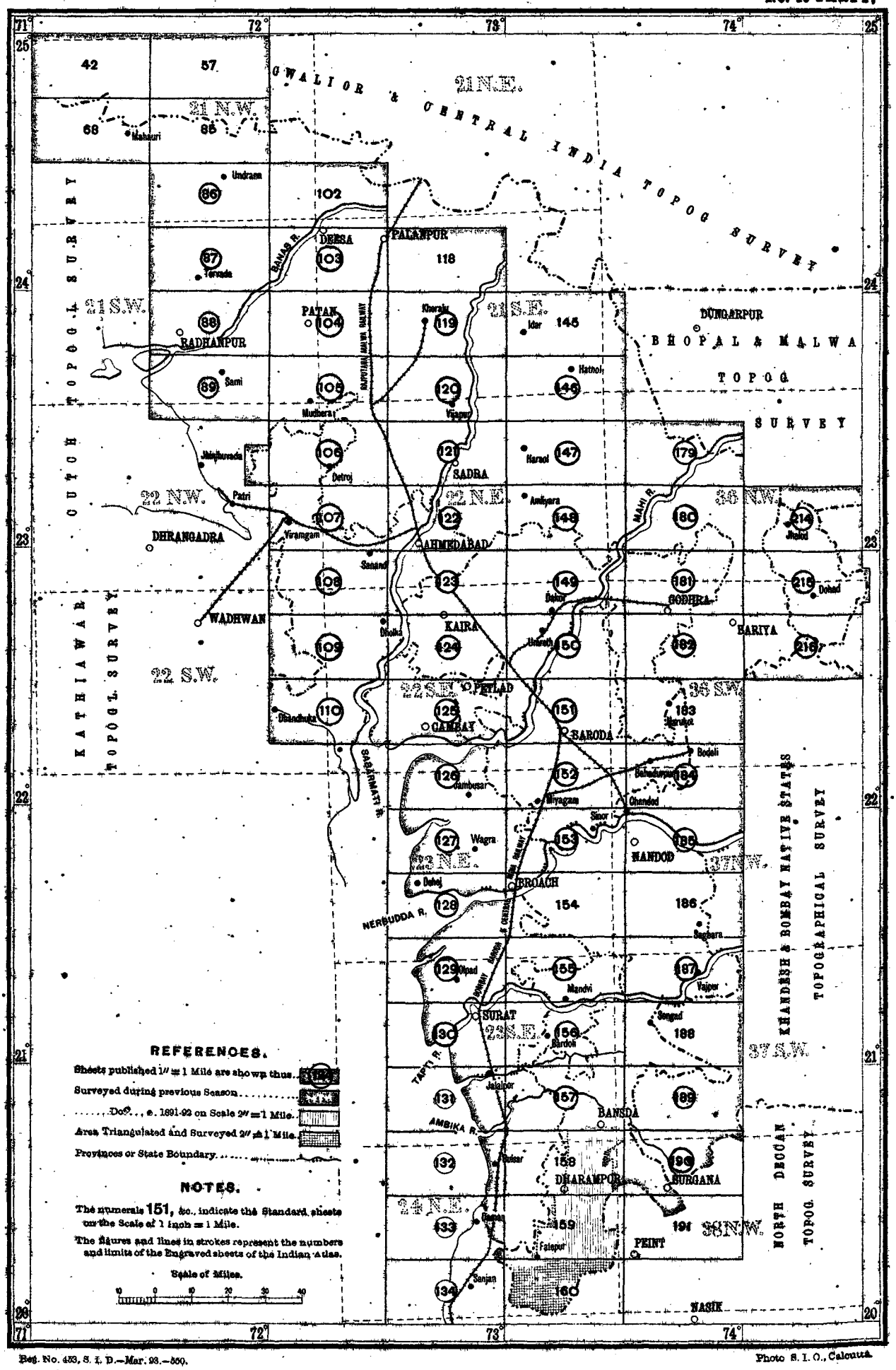
The operations of the different sections will be described separately.

* Lieutenant Close reports favourably of all his assistants, and speaks in high terms of the zeal and ability shown by Mr. J. Hickie in carrying out the most difficult part of the approximate work.

BOMBAY SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN GUJRAT.

No. 10 PARTY.



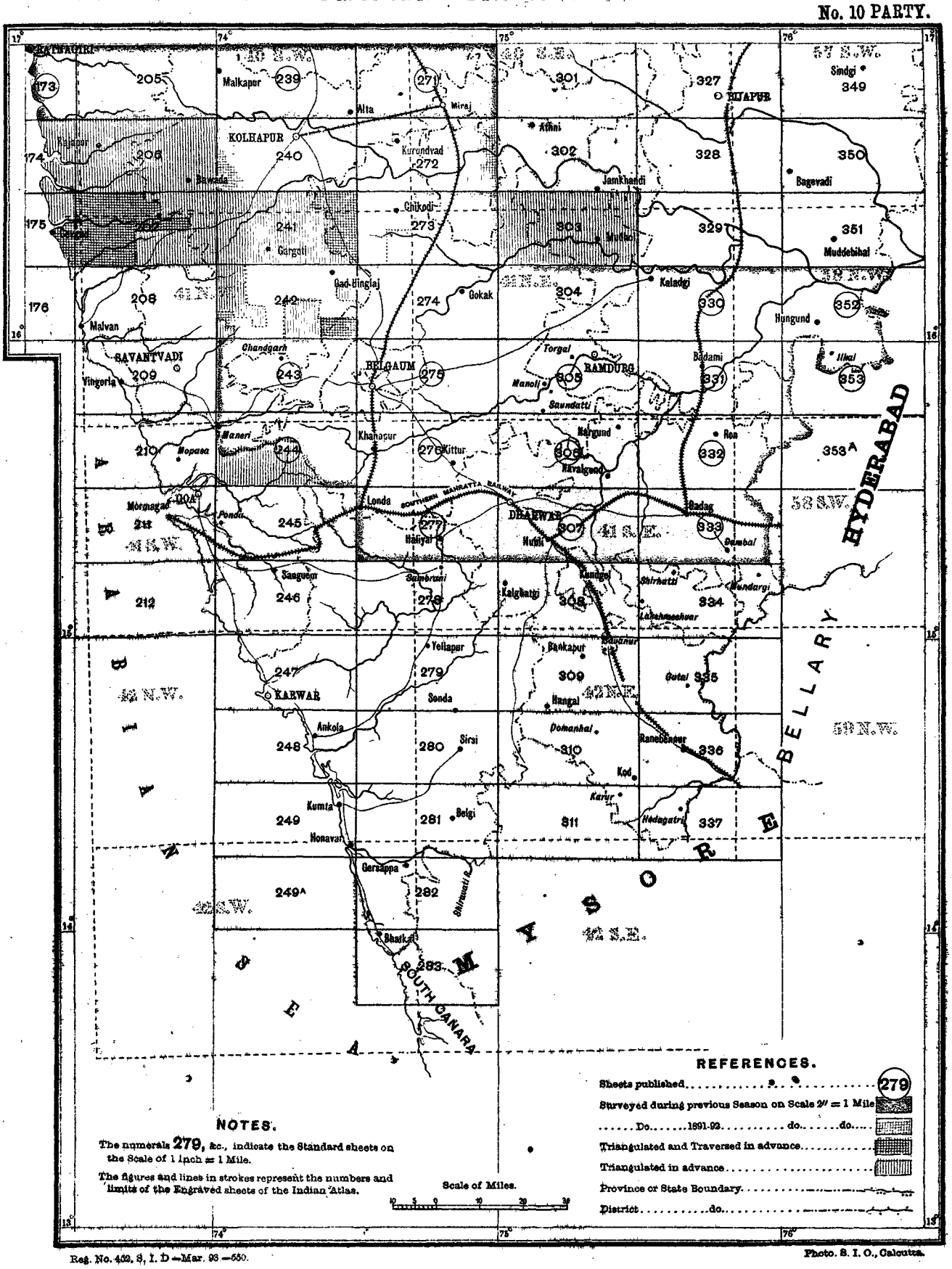
Reg. No. 453, S. I. D.—Mar. 93.—550.

Photo S. I. O., Calcutta.

BOMBAY SURVEY.

INDEX TO THE BOMBAY TOPOGRAPHICAL SURVEY IN SOUTHERN MARATHA COUNTRY.

No. 10 PARTY.



NOTES.

The numerals **279**, &c., indicate the Standard sheets on the Scale of 1 inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published..... 279

Surveyed during previous Season on Scale 2″ = 1 Mile

..... Do.....1891-92..... do.....do.....

Triangulated and Traversed in advance.....

Triangulated in advance.....

Province or State Boundary.....

District.....do.....

Reg. No. 402, S, I. D.—Mar. 93.—550.

Photo. S. I. O., Calcutta.

Gujarat Survey.

75. The area surveyed in Gujarat, amounting to 841·2 square miles, formed part of sheets Nos. 158, 159 and 160, and comprised the remaining portions of the State of Dharampur and the detached *pargana* of Nagar-Haveli belonging to the Portuguese Settlement of Daman. The out-turn of the season's work in Gujarat is as follows:—

Triangulation	300 square miles.
Detail survey, on 2-inch scale	841 „ „

The survey of the Gujarat Province is now completed.

76. The country operated in is covered with forest, and the features of the ground are of an intricate nature. Towards the close of the field season, fever was rife among the men forming the Gujarat detachment; Mr. Stotesbury himself was also a sufferer. The accuracy of the work was tested by 149 linear miles of traversing, besides a number of *in situ* examinations.

Southern Maratha Survey.

77. The survey in the Southern Maratha country was carried on in sheets Nos. 240, 242, 272 and 273, comprising portions of Native States under the Kolhapur Agency and portions of the Belgaum district.

Triangulation in advance of detail survey for next field season was effected in sheets Nos. 303, 241, 207 and 175; also the traversing of the tri-junctions of village boundaries in British territory. The traversing in sheet No. 303 had to be abandoned owing to the famine prevailing in that locality.

78. In addition to the above, a survey of Kolhapur City and Cantonment was made, on the scale of 8 inches = 1 mile: the original sheets of the City portion, surveyed by Mr. Owen, of the Bombay Revenue Survey, some five years ago, and kindly lent by the Kolhapur Durbar, were utilised for incorporation in the map by the process of reduction.

79. The out-turn for the season in the Southern Maratha country amounts to—

Triangulation	1,810 square miles.
Traversing	642 linear „
Detail survey, on 2-inch scale . . .	1,680·4 square „
Ditto, on 8-inch scale . . .	11·5 „ „

80. The accuracy of the survey was tested by 136·4 linear miles of traverse, as well as by *in situ* examinations.

81. The country is open, flat and easy, except in the vicinity of the *ghâts* in sheets Nos. 240 and 242, where it is hilly and occasionally covered with scrub jungle.

82. Influenza was prevalent at the beginning of the field season, and incapacitated Mr. Tapsell for a short time, whilst one of the surveyors died of this complaint. There were also many cases of guinea-worm amongst the surveyors and *khalâsis*.

83. The mapping, including certain arrears of the previous season, is well in hand, and every effort will be made to complete it all before the party takes the field again.

84. Lieutenant Fraser, R.E., was posted to this party when appointed to the Department in October, 1891. He surveyed 94 square miles in the hilly portions of the Southern Maratha country in a very creditable manner, and during the recess has become thoroughly conversant with the various computations. He has proved himself to be an intelligent, painstaking and zealous officer.

85. The recess office was inspected by the Officiating Surveyor-General in August, 1892, who expressed his satisfaction with the season's progress and the general arrangements made by the officer in charge.*

* Major Hobday reports favourably of all the Extra and Sub-Assistant Superintendents, and makes special mention of Messrs. Stotesbury and Tapsell both in the field and in recess.

BALUCHISTAN.

No. 15 Party.

86. The operations upon which the party was employed during the season were—

Personnel.

Colonel T. H. Holdich, R.E., Superientendent, 1st grade, in charge.
Captain R. J. H. L. Mackenzie, R.E., Deputy Superintendent, 2nd grade.
Mr. T. E. M. Claudius, Extra Assistant Superintendent, 3rd grade.
„ E. A. Wainwright, Extra Assistant Superintendent, 4th grade.
„ H. T. Kitchen, Extra Assistant Superintendent, 4th grade, from 25th June 1892.
„ G. P. Tate, Sub-Assistant Superintendent, 1st grade, from 13th July 1892.
Yusaf Sharif, Khan Bahadur, Sub-Assistant Superintendent, 3rd grade.
Hira Singh, Rai Bahadur, Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Imam Sharif, K.B., Ahmed Ali, K.B., Abdul Guffar, K.S., Hussain Bux, Sheik Mohiuddin, Mohammed Naki, Nizammuddin, Madhat Khan, Ahmed Hussain, Jamuldin, and Wahid Bux.

(1) A detailed reconnaissance for a line of railway communication between Kurrachee and Kharán.

(2) Triangulation, including the extension of the Makrán series to the west, the revision of previous triangulation in Wad, and the extension of triangulation southwards to the coast, for $\frac{1}{8}$-inch scale topography.

(3) Topography on the 2-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch scales.

87. Kurrachee was selected as the most convenient field head-quarters for the general direction of the party. The country under survey is generally so rough and inaccessible that inter-communication between the different sections of the party actually in the field is almost an impossibility. There is no treasury at Bela on which any reliance can be placed for money supplies, and only an inefficient postal service between that place and Kurrachee, whilst the generally unsettled state of the trans-frontier of Sind renders constant appeals to the local political authorities a necessity. From Kurrachee then, as the local head-quarters, the party took the field early in December 1891.

88. The reconnaissance, which was specially applied for by the Military authorities, was entrusted to Captain Mackenzie, R.E., who was employed on it during the whole season. The work was completed and will form the subject of a separate report.

89. As regards the employment of the European and native subordinate staff, the same procedure, as regards the breaking up of the native establishment into squads and placing them directly under the supervision of a European assistant, was adopted as in previous years, and with the same success. In a wild and difficult country like Baluchistan, young hands are especially dependent on constant supervision, even after their instruction is complete.

90. The extension of the Makrán series was carried out by Mr. T. E. M. Claudius, and forms a perfectly connected series based on the Great Indus Series of the Great Trigonometrical Survey, extending through the districts of Bela and Makrán, and on to the borders of Persia, following closely the parallel of 26° N. latitude.

91. Mr. Claudius was also in charge of a squad of detail surveyors working in Kolwah and Makrán on the $\frac{1}{4}$-inch scale, which brought in an area of 19,084 square miles of previously unexplored country. The country was generally very hilly and barren, and the squad experienced a great deal of difficulty owing to the unsettled state of the tribes. The out-turn of this section is—

	Square miles.
Triangulation	7,500
Topography, $\frac{1}{4}$-inch scale	19,084

92. The revision of the previous triangulation in Wad was entrusted to Mr. E. A. Wainright, who completed it with much difficulty owing to the wild and barren nature of the country in that tract. On completion of his triangulation, Mr. Wainright had charge of a squad of surveyors, who were to carry out the detail survey on the $\frac{1}{2}$-inch scale of the ground in which the triangulation had been revised, but this could not be effected on account of political difficulties and the unsettled state of the country. He was, therefore, obliged to move his squad down to Bela, where the survey was on the $\frac{1}{2}$-inch scale in connection with

Captain Mackenzie's reconnaissance. The out-turn of Mr. Wainwright's section is—

	Square miles.
Triangulation	1,900
Topography, ½-inch scale	603

93. The extension of triangulation for the ½-inch detail survey was carried out by Rai Bahadur Hira Singh, the area triangulated amounting to 3,000 square miles. He also effected a reconnaissance on the ¼-inch scale of his triangulated area.

94. In addition to the ordinary geographical surveys on the ¼-inch scale, Khan Bahadur Yusaf Sharif was deputed to make a survey on the 2-inch scale about Gwatar, and returned with an area of 26 square miles of topography along the coast.

95. The services of three of the best draftsmen in the party were retained during the field season at the field head-quarters, Kurrachee, to bring up arrears in mapping under the direct supervision of Colonel Holdich. Besides this supervision, and the general direction of the different detachments in the field, Colonel Holdich was enabled, through the kindness of the telegraph officials, who gave him occasional passages in the telegraph steamer, to visit the coast of Makrán, and inspect the work of such of the detail surveyors as were working near the coast. Colonel Holdich has submitted an interesting report on this part of the country, which has been separately printed. Subsequently he was enabled to visit some of the principal ports of the Persian coast, and thus to make arrangements for a general scheme for the purpose of obtaining reliable data, which may be of great value in revising Persian mapping.

For the facilities thus afforded him, Colonel Holdich is much indebted to Mr. Brooke, the Director General of Telegraphs, and to Mr. B. Ffinch, the Director of the Indo-European line.

96. The field operations closed with the return of the last surveyor to Quetta on the 20th May. The health of the party on the whole was not good. Three deaths occurred among the *khalásis*, and two soldier-surveyors had to be invalided from the field.

97. The total out-turn of work executed by the party is as follows:—

	Square miles.
Triangulation	12,418
Topographical survey, 2-inch scale . . .	26
,, ,, ½ ,, ,, . . .	603
Geographical ,, ¼ ,, ,, . . .	19,084

98. The following reports were drawn up by the officers of the party during the year, and extracts therefrom will be found in the appendix:—

(1) History and Ethnography of Makrán, by Colonel Holdich.
(2) Description of the country surveyed, by Mr. Claudius.

99. During the recess, all the computations appertaining to the triangulation executed during the field season have been completed in duplicate, and the fair mapping of three sheets on the ½-inch scale and six sheets on the ¼-inch have been completed and sent for publication. A map on the scale of 16 miles = 1 inch, comprising the past season's work of this party, has been prepared and sent to the Drawing Office at Simla. In addition to the above, the mapping of six sheets on the ¼-inch scale is in hand.

100. A special survey on the 6 inch scale in the neighbourhood of Quetta has been started on the requisition of the Military authorities and has made fair progress. Two sub-surveyors were attached to the camp of the Political Agent at Fort Sandeman to accompany that officer in his tour through the Kundar and Chakan valleys. The services of Khan Bahadur Imam Sharif were placed at the disposal of the Home Government for employment in Africa.

101. During the year Surveyor Ahmed Ali Khan has received the title of Khan Bahadur for his good work on the frontier; and Surveyor Abdul Guffar has been distinguished by the title of Khan Sahib for his services in the Black Mountain Expedition of 1891.

His Excellency the Commander-in-Chief also has been pleased to consider

the services rendered in military interests of the undermentioned subordinates of this party:—

Sub-Assistant Superintendent Yusuf Sharif, K.B.,
Sub-Assistant Superintendent Hira Singh, K.B.,
Sub-Assistant Superintendent Imam Sharif, K.B,
Surveyor Ahmed Ali, K.B.,

and has caused a letter to be addressed to each of them conveying His Excellency's recognition and approbation of their services, and further has awarded them the sum of Rs. 500 each as an honorarium.

102. The programme for the ensuing season, which is subject to considerable modification, may be roughly indicated as follows:—

Messrs. Claudius and Graham, with five surveyors and sub-surveyors, will remain with the field head-quarters of the party at Quetta, and will be employed on large scale surveys for military and for revenue purposes in the Quetta district. When the weather does not admit of field work, they will be employed on mapping.

Mr. Wainwright with two surveyors will be detailed for special duty on the Persian border, where a good deal of important reconnaissance can be done and where triangulation is still possible.

Mr. Kitchen will continue the ½-inch topography of the Las Bela district, working from the Sind border, near Kurrachee, northward.

One surveyor will remain attached to the Political Agent at Fort Sandeman; another will complete the ¼-inch survey of the Kolwah district; and another will be employed on special duty near Kharán.

Finally, Captain Mackenzie, with Rai Bahadur Hira Singh and a small party, will remain as at present on the Gomal line, strengthening triangulation in the first instance and awaiting future eventualities in that direction.*

HIMALAYAS, PUNJAB.

No. 18 Party.

103. The party continued under the charge of Major Gore for the greater part of the field season, and on that officer proceeding on six months' furlough to England, the charge devolved on Captain J. M. Fleming, who held it until the 16th July 1892. Captain Fleming's services then being required in Burma, Captain Bythell, R.E., was placed in charge until Major Gore's return from furlough.

Personnel.

Major St. G. C., Gore, R.E., Deputy Superintendent, 1st grade, in charge up to 25th March 1892.
Captain J. M. Fleming, S.C., Deputy Superintendent, 2nd grade, in charge from 25th March up to 16th July 1892.
Captain W. J. Bythell, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 16th July 1892.
Lieutenant C. H. D. Ryder, R.E., Assistant Superintendent, 2nd grade.
Mr. C. D. Potter, Extra Assistant Superintendent, 3rd grade.
„ W. Robert, ditto, 4th „
„ W. A. Fielding, Sub-Assistant Superintendent, 1st grade.
„ P. F. Prunty, ditto, 1st „
„ R. W Senior, ditto, 1st „

Surveyors and Sub-Surveyors.

Shah Nasir-uddin, Atma Singh, Wahid Ali Khan, Ramsaran and 33 others.

104. In November 1891 Lieutenant Ryder, R.E., on appointment to the Department, was posted as an assistant to this party with a view to his being trained in survey duties.

105. The work now in progress consists of—

I.—A survey, on the scale of 4 inches=1 mile, of the cultivated portions of Kángra district with its sub-division of Kulu, the more mountainous portions and grazing-grounds being mapped on the smaller scale of 1 inch=1 mile.

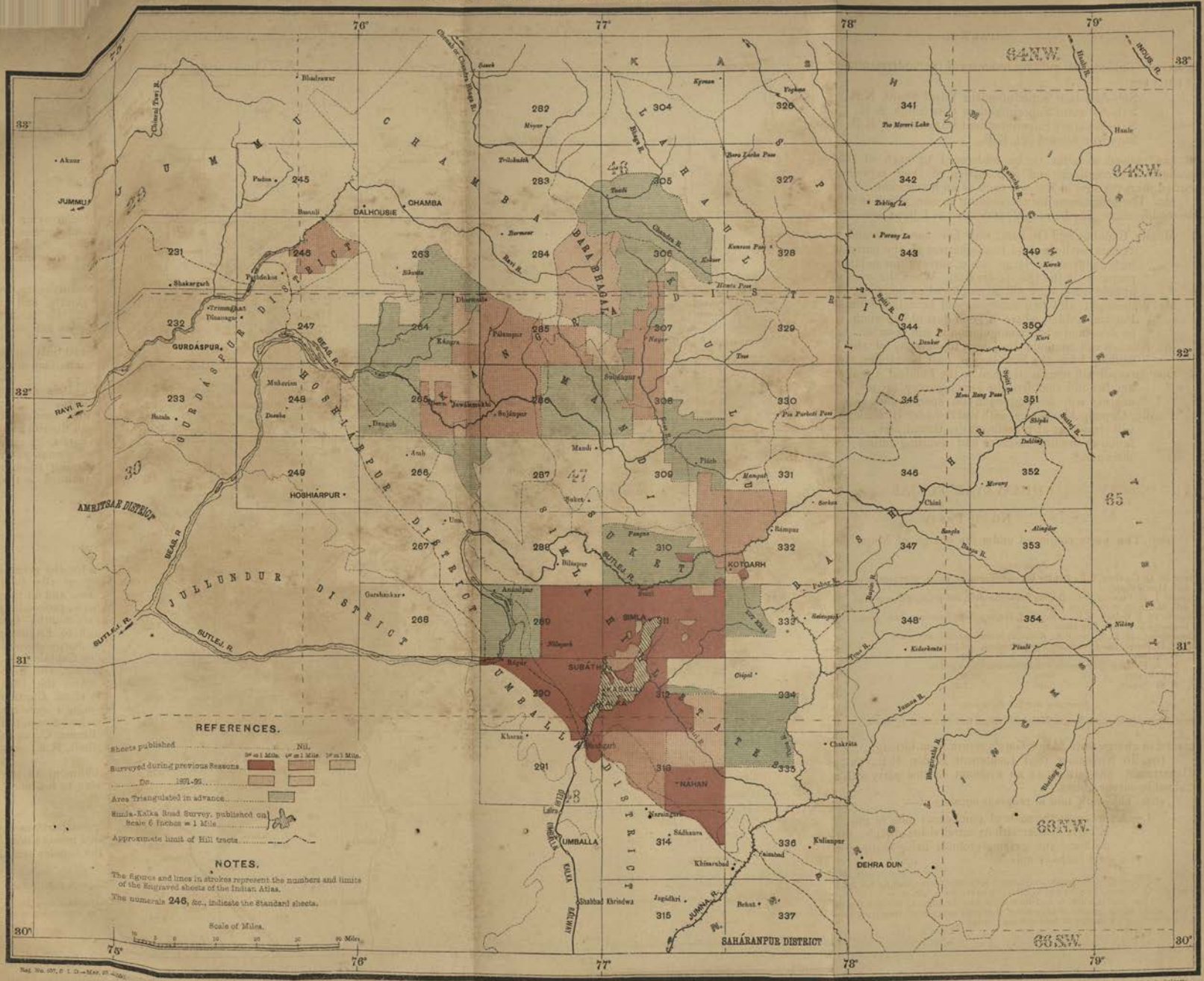
* Colonel Holdich speaks in high terms of the services rendered by his assistants, both European and native. Of Messrs. Claudius and Wainwright he reports as follows:—

"I am much indebted to both these officers for the able way in which they carried out my instructions. Without the steady support of experienced European surveyors of their type, it would be almost impossible to deal with such a country as Southern Baluchistan."

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS.

No. 18 PARTY.



II.—A survey, on the scale of 4 inches=1 mile, of the Government forests in Kángra and Kulu.

III.—Surveys, on the scale of 2 inches=1 mile, of the Simla Hill States with Mandi and Suket, particular attention being paid to the State boundaries.

To this has now been added—

IV.—A special survey, on the scale of 4 inches=1 mile, of the reserved forests situated in various Native States constituting the Simla Hill States. These forests have only lately been reserved and are in process of demarcation, and standard forest maps of them are required.

106. The party took the field early in November, with the exception of Mr. Senior, who was sent earlier into Kulu to carry on triangulation. On account of the arrears of mapping which had accumulated under Major Gore's predecessor, it was determined to retain a portion of the party at Simla to work off as much as possible of the arrears. With this view Messrs. Potter and Robert with five surveyors remained at Simla, and were employed throughout the field season in correcting and completing the sheets in arrear. This arrangement has proved very satisfactory, no less than 32 sheets having been cleared off.

107. The detachments for the most part returned from the field during May, some few remaining out until June, having been employed in completing those portions of Chota Bangahal which were left incomplete last season on account of the heavy snowfall.

108. No regular work was done in Kulu during this season, as it had been decided to utilize the fine weather immediately after the rains for this purpose in future; and as it was not possible to commence this arrangement during the season under report, the men of the Kulu detachment were utilized in Simla as above mentioned.

109. In consequence partly of these arrangements and partly of the disorganization of the country caused by a serious epidemic of cholera, the out-turn of the party is much smaller than usual, the areas topographically surveyed being as follows:—

Localities.	Scale.	Area in square miles.
District Kángra . . .	4 inches=1 mile	245
Simla Hill States . . .	2 inches=1 mile	239
Ditto Forests . .	4 inches=1 mile	45
	TOTAL .	529

The area triangulated in advance for future topography during the year was 1,157 square miles, 556 square miles having been prepared for 4-inch and 601 square miles for 2-inch survey.

110. For the Forest Department in Kángra, 51 forest blocks were surveyed either wholly or in part, those under the direct charge of the Forest Department being found well demarcated with permanent pillars at the salient points. In Kulu four forest blocks were surveyed.

111. The special surveys of the forests in the Simla Hill States were commenced during the season. Those belonging to the Patiala State were first commenced, as their demarcation was in a more forward state: two surveyors were employed on them, and in all 45 square miles, or 28,804 acres of demarcated forest, were surveyed.

This area is comprised in 10 first class and 64 second class forest blocks of which the survey is completed, and 7 first class and 5 second class blocks which have been partially surveyed. A little delay occurred owing to the demarcation of the second class forests not being at first quite finished, but this was soon rectified by Mr. Minniken, the Forest Officer deputed for the purposes of the

demarcation. This demarcation is well carried out, and promises to be permanent. As yet however no interior boundaries between the various forests have been laid down.

112. In the ground which came under survey on the 2-inch scale in the Simla Hill States no forests were found demarcated, the territory belonging to the Sirmur State and their forests being only in process of demarcation. These forests will be surveyed on the 4-inch scale, and their boundaries also subsequently entered on the 2-inch maps.

113. Three soldier-surveyors were under instruction during the season. Of these, Havildar Budhihal completed his course and returned to his regiment a well qualified surveyor and reconnoitrer. The other two men who where sent direct from the Assam Military Police without any previous training at Roorkee College are still under instruction, but they are reported as never likely to become very efficient.

114. The programme for the ensuing field season includes the extension of the triangulation in Kulu, Mandi, and the Simla Hill States, the continuation of the 4-inch detail survey in Kángra and Kulu, the 2=inch work in Mandi, and the special 4-inch forest surveys in Patiala and Sirmur.

115. The recess office of the party at Simla was inspected by the Deputy Surveyor-General in October, who reports that good progress has been made in working off the arrears alluded to in last year's report. In consequence of improved administration the party is now working very efficiently, and no further necessity exists for withdrawing surveyors from their field work during the cold weather to bring up accumulated arrears of mapping or computation. They are not yet entirely cleared off, but have been reduced to manageable dimensions under Major Gore's judicious control.*

MERGUI DISTRICT, LOWER BURMA.

DETACHMENT.

Personnel.
Mr. A. J. Gibson, Extra Assistant Superintendent, 1st grade, in charge.
„ J. A. Higgs, Sub-Assistant Superintendent, 1st grade.
7 sub-surveyors.

116. In consequence of the representation of Mr. Hughes, Superintendent, Geological Survey Department, and of the local district officials, the Burma Government again requested that the topographical survey of the district of Mergui should be continued, but suggested that the party should be reduced to a detachment. This was accordingly done, and it was placed under the superintendence of Mr. A. J. Gibson.

117. The programme was arranged in consultation with Mr. Hughes, and consisted of the 1-inch topographical survey of—

(1) the country comprised in sheets Nos. 218 and 219 round Maliwun and to the south as far as Point Victoria, after which the work was to be extended northwards up to the parallel of latitude 10°30″ if possible.
(2) a portion of country near Banhuni in sheet No. 217, covering an area of about 40 square miles.
(3) a portion of sheet No. 226 on the Great Tenasserim river.
(4) a traverse survey along the courses of the Pagchan and the Great and Little Tenasserim rivers.
(5) surveys of the separate tin mines on the 8-inch scale. These were undertaken at the request of the Financial Commissioner, made after the commencement of the field season.

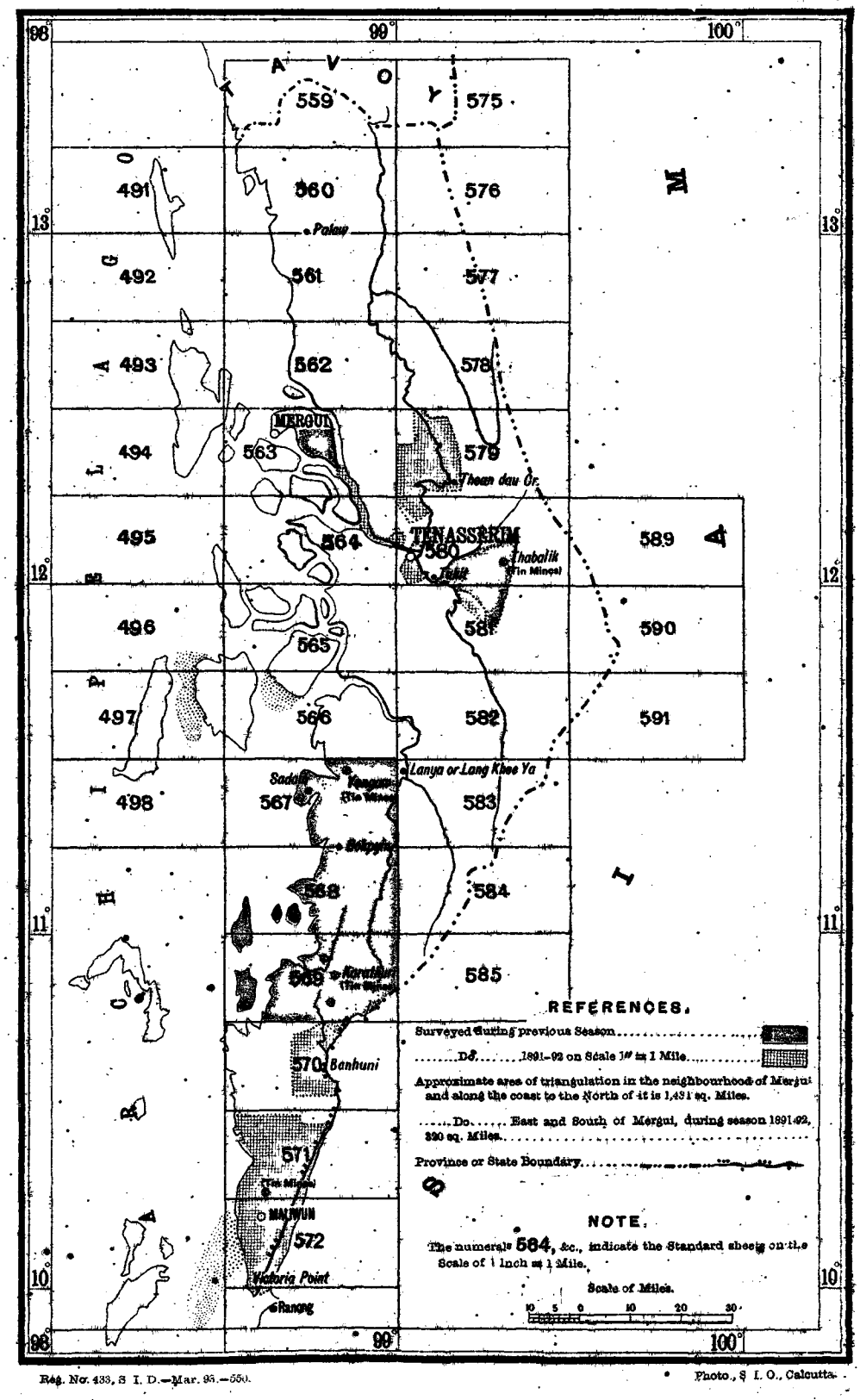
118. It will be seen from the index map that the work in the south of the peninsula is about 120 miles from that on the Tenasserim river: this necessitated the sub-division of the detachment into two portions. One, consisting of four

* Maior Gore reports very favourably of Lieutenant Ryder, R.E., and of Messrs. Potter, Roberts, Fielding and Senior, and also of Surveyor Shah Nasiruddin and Sub-Surveyor Asmatullah.

BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN DISTRICT MERGUI.

DETACHMENT.



Reg. No. 433, S. I. D.—Mar. 93.—550.

Photo., S. I. O., Calcutta.

sub-surveyors under Mr. Higgs, worked in the south and completed the work under (1) and (2) as well as the traverse along the Pagchan river; the remainder of the party worked under Mr. Gibson on the Tenasserim rivers, and completed (3) and the traverse survey of the Tenasserim rivers. The 8-inch surveys of the tin mines, which were dotted about in the different areas under survey, were taken up by the sub-surveyors as was found convenient.

119. The total out-turn of the party was 765 square miles of topography on the 1-inch scale; 86 linear miles of plane table traverse along the Pagchan and Great and Little Tenasserim rivers; surveys of 81 separate tin mines on the 8-inch scale; 31 linear miles of theodolite traversing, and about 320 square miles of triangulation: this more than completed what had been originally asked for as absolutely necessary, and, considering the nature of the country, the out-turn may be considered very satisfactory and creditable to Mr. Gibson and his assistants.

120. The party, which had recessed at Bangalore, assembled at Mergui on the 4th November 1891. As Mr. Gibson had been detained at Bangalore in order to meet Mr. Hughes, the starting of the field parties devolved on Mr. Higgs. During the latter part of November and December progress was slow, owing to bad weather, but in January a satisfactory out-turn was reported, and this continued until the end of May, when the field season closed. Recess work recommenced at Bangalore on the 21st June 1892.

121. The nature of the country has already been alluded to in previous reports; and the same dense forest, steep hills, mangrove swamps and absence of roads were again met with this year in the Maliwun sub-division. The Tenasserim valley however is not so rugged, and owing to the existence of villages and open ground and the possibility of occasionally obtaining rice, the difficulties experienced in that portion of the work were not so great. The Great Tenasserim river is navigable by steam-launch as far as Tenasserim only; from thence it is possible to take country-boats up another 15 miles to Tarabong, after which only canoes can proceed. The Little Tenasserim river is navigable for only a few miles above its junction with the larger river.

122. As in previous seasons, the provisioning of the detached camps was a source of great responsibility to the officer in charge, as a failure in this respect might have led to very serious results. Arrangements were made with a native firm at Mergui to furnish rice, *dhal*, flour and other necessaries, but, owing to the prevailing scarcity, rice was not forthcoming in sufficient quantity to stock the depôts for the whole season; enough was despatched to last for two months, the remainder being subsequently forwarded by the S.S. "Mergui" and by boats, as the steam-launch was temporarily laid up through an accident to her rudder. Two main depôts were formed at Tenasserim and at Victoria Point, and these two were supplied direct from Mergui: the minor depôts, from which the detached camps drew their supplies obtained their stores from these two main depôts. A further source of difficulty was the want of water on the islands: in one case two signallers had been left on an island where there was no water, and their boat, which had gone to the mainland for a fresh supply, was detained by stress of weather; the men were thus left without water for 1½ days, when they were relieved by Mr. Gibson in the steam-launch; had it not been for the launch, the men would probably have died before assistance could have reached them. The above were not the only dangers the men were exposed to, for on two occasions they were attacked by bears: in one case a man was mauled, though not very severely, and on another occasion a small squad of men were attacked and driven into the jungle, where they lost themselves; search parties were sent out, but owing to bad weather and fog the men could not be found, and it was not until after five days that the almost starved men found their way back to camp. One man died subsequently of bronchitis brought on by exposure at that time.

123. In the Tenasserim valley, a comparatively small amount of sickness was experienced, and there were no deaths. The men working in Maliwun were not so fortunate, and suffered a good deal from fever, dysentery, bronchitis, and sores caused by leech bites. There were five deaths from fever, besides the one from bronchitis alluded to above. This represented a loss of about 5 per cent. on the establishment of the Maliwun section.

124. During the recess, the computations of the season's triangulation were completed, and tracings of the field sheets were made for the Geological Survey

Department and for the local authorities. The final completion of the standard sheets will be made next year when the field work and the triangulation are all finished: to make fair copies of the work as it stands at present would only entail double labour, as some parts have not as yet been correctly located by triangulation.

125. Mr. Hughes having again applied for the service of the detachment for the survey of the Tenasserim coal field and the completion of the Maliwun township, sanction has again been given by the Government of India to its continued employment on condition that the extra expenditure shall be borne by the Burma Government. It has accordingly been decided that the programme for 1892-93 shall be the 1-inch topographical survey of the coal field near Tenasserim and of the country between it and Mergui, and as much as possible of sheets Nos. 211 and 212, and the completion of sheet No. 217 to the south. The detachment has been still further reduced by the transfer of Mr. Gibson to Assam, which has necessitated giving charge of the detachment to Mr. Higgs. This officer is very junior to have independent charge of a detachment in so difficult a country, but he has been so highly spoken of in connection with his energy and good arrangements in this very work that there is no doubt he will carry it through to a satisfactory conclusion. The work near Tenasserim will, in the first instance, be undertaken by Mr. Gastaud and three sub-surveyors of No. 7 Party, a part of which will be employed on the cadastral survey of the cultivated portions of the valley in the immediate neighbourhood; as Mr. Higgs completes the work to the south he will move his men northwards, and all will work together.

126. The detachment was inspected at Bangalore by the Officiating Surveyor-General, who was well satisfied with the state in which he found the party.*

DISTRICTS IN THE NEIGHBOURHOOD OF ADEN.

DETACHMENT.

127. This detachment was formed in October, 1891, for the survey of the districts around Aden, occupied by the various Arab tribes protected or subsidised by Government. This area is roughly a semi-circle with a radius of about 70 miles described with Aden as centre, and extends from the coast to the borders of Turkish Arabia. The detachment was placed in charge of Captain Wahab, Deputy Superintendent.

Personnel.

Captain R. A. Wahab, R.E., Deputy Superintendent, 1st grade, in charge.
Mr. E. Graham, Sub-Assistant Superintendent, 1st grade.

Surveyors.

Asghar Ali and Jaffir Ali.

128. The party reached Aden on the 25th October, and remained in the field until the beginning of April, returning to India by the I. M. S. "Dalhousie" on the 24th idem. The out-turn of work during this period included the triangulation of nearly 7,000 square miles, and the detail survey on the $\frac{1}{2}$-inch scale of 4,426 square miles of country. The latter area includes all the tracts under British influence with the exception of a small portion of the Subaihi country and the Radfan range, which could not be entered by the surveyors owing to the hostility of the inhabitants.

129. The country surveyed consists of two distinct zones differing widely in physical character. The southern portion, about one-third of the whole, is an open plain, extending some 80 miles along the coast on either side of Aden, and varying in width from 6 to 30 miles. The remaining two-thirds is a mountainous tract, rising steadily from the maritime plain to the Yaman highlands, where

* The officer in charge of the detachment speaks very highly of Mr. Higgs' zeal and energy in overcoming difficulties; he had the superintendence of the men working in the Maliwun township, and in addition to this he himself completed 258 square miles of topography. Mr. Hughes has also made special mention of the good services rendered by Mr. Higgs. Shedi Lall, Sub-Surveyor, is commended for a good out-turn in a difficult country, and the writer, Babu S. K. Chatterjee, is reported as having given satisfaction.

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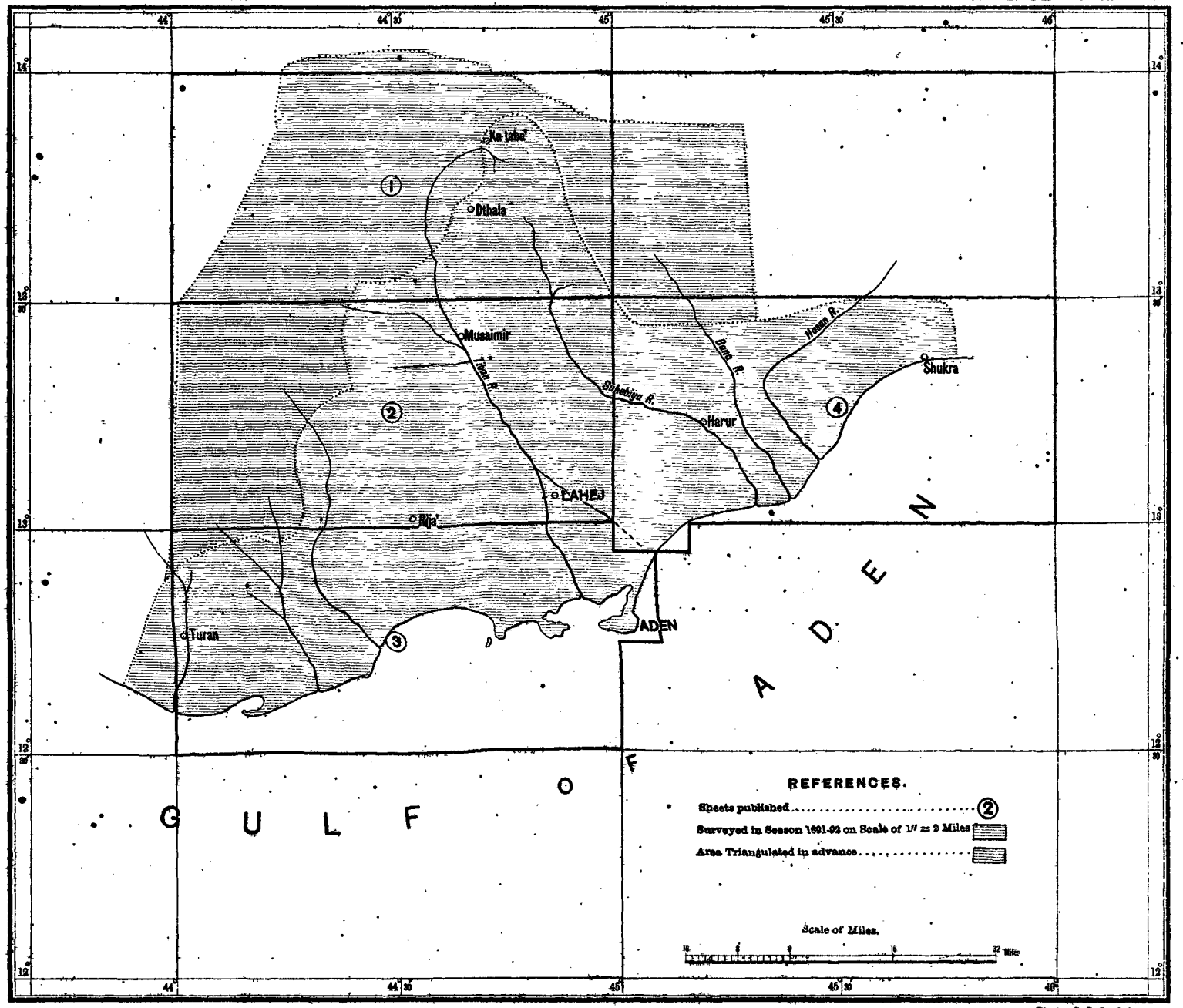
ADEN DETACHMENT.



Reg. No. 560, S. I. D.—Mar 93.—550.

Photo. S. I. O., Calcutta.

several peaks on the northern margin of the season's work exceed 10,000 feet in altitude.

130. The greater part of the maritime plain is a sandy tract, covered in places with coarse desert grass and acacia jungle; but it contains in Lahej and Abyan oases of the highest fertility, watered respectively by the Tiban and Bana rivers, both perennial streams draining a large area of mountainous country. Several other mountain torrents cross the plain, along the dry beds of which water is found in wells at a depth of 60 to 100 feet. Except in the oases, there are no villages or settled inhabitants, but encampments of nomads are always to be found in the neighbourhood of the wells.

The lower hills consist for the most part of barren, stony ridges with occasional fertile valleys; the higher ranges are generally flat-topped, often forming plateaux of considerable extent, with villages and fields on their highest summits.

131. The inhabitants are Arabs divided into various tribes and sub-tribes, independent as far as their internal affairs are concerned, but receiving subsidies from Government, in return for which they agree to abstain from raids on British territory and on caravans trading between Aden and the interior. These tribes in the neighbourhood of Aden, such as the 'Abdali and some sections of the Fadthli and Subaihi tribes, are amenable to British influence, but those inhabiting the remoter hills have little or no respect for our power.

An interesting description by Captain Wahab, R.E., of the country surveyed and of the tribes inhabiting it, will be found in the appendix.

132. Prior to the arrival of the party, the Political Resident had communicated with all the local chiefs of importance, and made all possible arrangements to avoid friction with the inhabitants. Military escorts were provided to each detached party, of sufficient strength to protect the surveyors, and a native political officer of great experience, Mr. Mahomed Salih Jaffir, K.B., was placed at the disposal of the Deputy Superintendent, and his assistance and advice were of the greatest value throughout the operations. Still, the survey was not carried out without opposition; twice the surveyors were attacked by large numbers of hostile Arabs, but were fortunately able to retreat without loss; as a rule, however, the judicious distribution of *bakhshish* was sufficient to overcome any opposition offered.

133. The party suffered greatly from sickness, chiefly malarial fever, during January and February, while working in the Tiban valley. No deaths occurred among the survey establishment, but four sepoys died and several more were invalided from illness contracted while acting as escort to the survey party.

134. During the recess, the whole of the mapping of the season's work has been completed in four standard sheets on the $\frac{1}{2}$-inch scale. A map has also been prepared on the scale of $\frac{1}{4}$ inch to a mile, embracing the whole area surveyed in one sheet, as well as a skeleton map on the same scale, showing the distribution of the tribes and principal sub-tribes.

135. Orders were received before the party left Aden for the survey, on the 8-inch scale, of the peninsula of Aden. As this would have involved the retention of the party in Aden during May and June at least, permission was given to its postponement till the next cold season, and it has now been further postponed on financial grounds for another year. If this work is taken up in 1893-94, advantage should be taken of the opportunity to extend the small scale survey in the unsurveyed part of the Subaihi country on the west and the Radfan hills and Bana valley on the east. One surveyor could do all that is required in three or four working days in each locality; but he should be accompanied by an experienced political officer, and a military escort strong enough to ensure the safety of the party, and to avoid the necessity of retreat in the event of hostile demonstrations.*

* Captain Wahab reports as follows regarding his assistants:—

"Both in the field and in office Mr. Graham is a thoroughly efficient officer, energetic, trustworthy and resourceful."

"Asghar Ali Beg is a quick and accurate topographer, and promises to make an excellent frontier surveyor."

"Jafir Ali is an excellent topographer and a good draftsman, but has not the personal qualities essential in a frontier surveyor."

FOREST SURVEYS.

CENTRAL PROVINCES.

No. 14 Party.

136. This party, under the charge of Colonel Wilmer, was employed in surveying the forest reserves of districts Hoshangabad and Betul on the 4-inch scale in continuation of the previous year's operations.

Personnel.

Colonel J. R. Wilmer, S.C., Superintendent, 2nd grade, in charge.
Mr. N. C. Gwynne, Extra Assistant Superintendent, 2nd grade.
„ J. Keating, Sub-Assistant „ 1st „
„ D. Campbell „ „ „ „
„ B. R. Hughes „ „ 2nd „
„ J. O. Greiff „ „ 3rd „

Surveyors and Sub-Surveyors.

Mohammad Zakaria, Hydar Ali, Gurdutt Singh, Kadir Sharif and 40 others.

137. It took the field in the first week of January, 1892, and by the end of April had completed the following work :—

(*a*) Triangulation in the forest reserves of district Nimar in sheets Nos. 8, 9, 14 and 15 below latitude 21°30′; also in a small portion of sheet No. 7.

(*b*) Theodolite traversing for laying down forest boundaries and fire lines and for supplying more fixed points for detail survey ; 454 linear miles were done in district Nimar in advance of topography, and 120 linear miles in district Hoshangabad for current season's detail work.

(*c*) Detail survey, on the 4-inch scale, in the Bori forest reserve, and the 2nd class forest in sheets Nos. 23, 24, 34 and 35 in district Hoshangabad. This completes the whole of the forests in districts Hoshangabad and Betul so far as they have been allotted to this party for survey.

(*d*) Classification of forest growth and soil of the area surveyed in detail during the season under report.

138. The total out-turn of the season's work is as follows :—

1. Triangulation of 684 square miles of country, fixing 669 points (including stations) and 670 heights.
2. Detail survey, on the 4-inch scale, of 483 square miles of forests.
3. Traversing of 574 linear miles.
4. The classification of forest growth and soils of the entire area surveyed in detail, *viz.*, 483 square miles.

139. The whole country under survey is very hilly, and operations were greatly impeded by the dense jungle and high grass which abounded in many parts. The forests in sheets Nos. $23\frac{S.E.}{3}$ and $24\frac{N.E.}{3}$ have been the regular haunt of man-eating tigers for many years, and in this year reports were continually being received of the presence of a man-eater, which were confirmed by kills in the vicinity. This retarded survey work very much, as the villagers deserted their fields in consequence, and labour could not be obtained. Scarcity of water was also felt, especially after the middle of March. There are no passes or roads of importance in the tract surveyed, except a few miles of the well-known Piparia-Pachmarhi road. The only rivers met with were the Tawa and the Denwa : these are fordable almost everywhere.

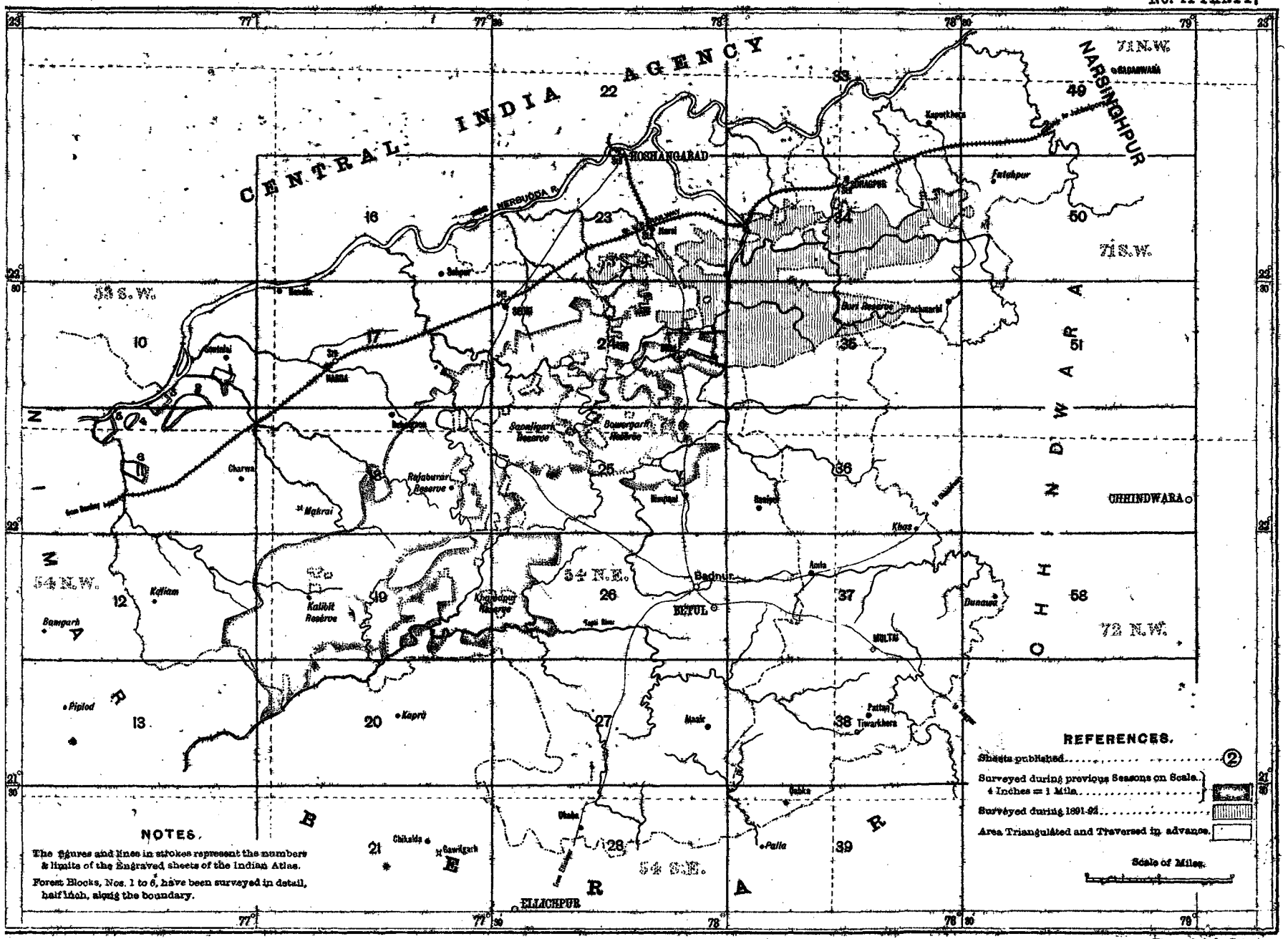
140. Judging from the number of casualties, the season under report has been exceptionally unhealthy. In the very beginning of the season, and before the party left Hoshangabad, pneumonia broke out in the camp. The timely distribution of quilts, and the administration of frequent doses of tea and quinine, had a beneficial effect in reducing the malady. Later on in the season the men suffered from fever and dysentery, and towards the end there were some severe cases of sunstroke. From one cause and another, thirteen deaths occurred in the party, being the greatest number on record since the commencement of this survey.

141. During the recess, all the sheets pertaining to the season's work have been drawn for reproduction and submitted to the office of the Deputy Surveyor-General in charge Trigonometrical Branch. They consist of 25 standard-sized

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEY IN DISTS. HOSHANGABAD & BETUL.

No. 14 PARTY.



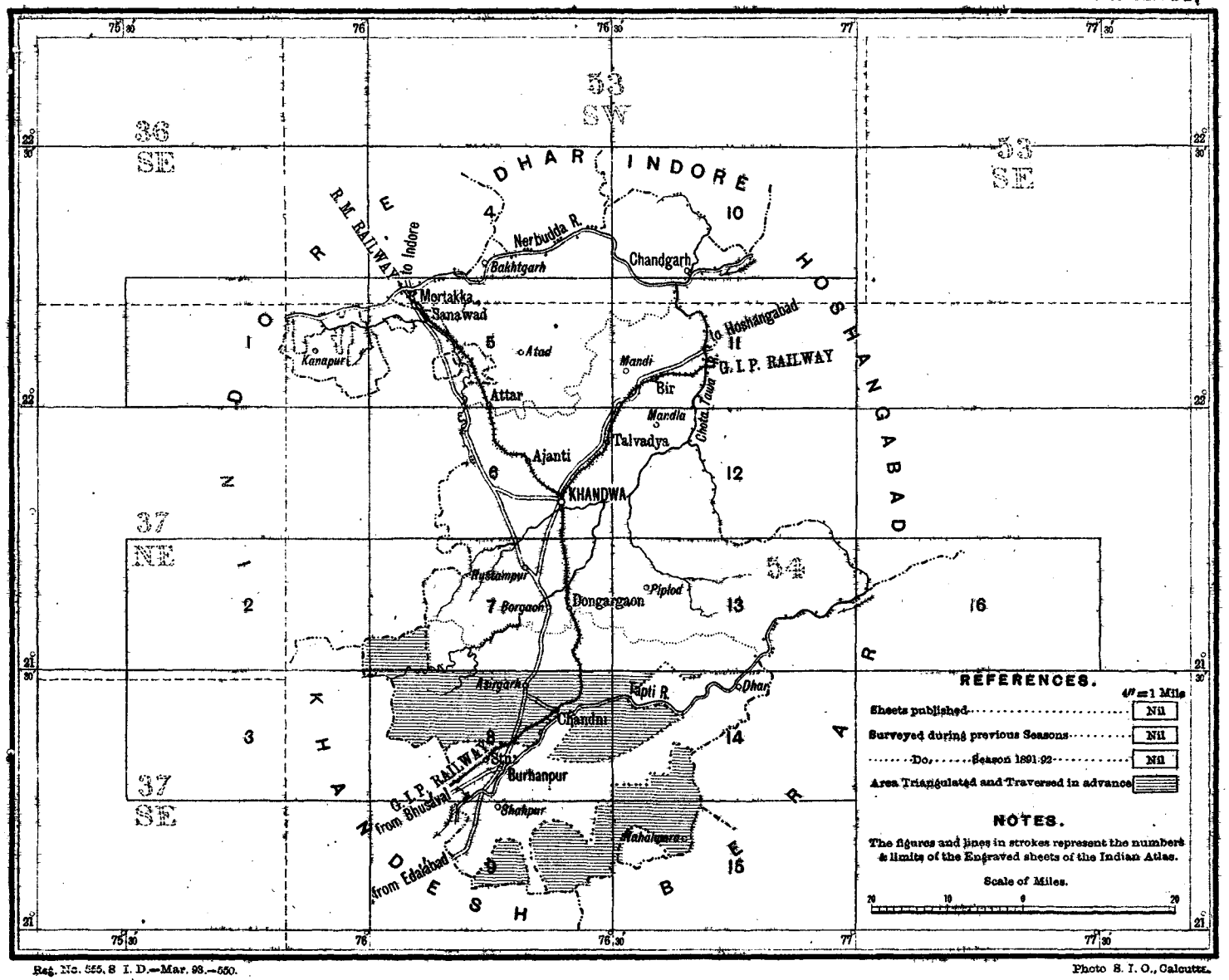
Reg. No. 542, S. I. D.—Mar. 98.—550.

Photo S. I. O., Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEY IN DISTRICT NIMAR.

No. 14 PARTY.



REFERENCES.

4" = 1 Mile

Sheets published	Nil
Surveyed during previous Seasons	Nil
..... Do. ..... Season 1891-92	Nil
Area Triangulated and Traversed in advance	

NOTES.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

20 10 0 20

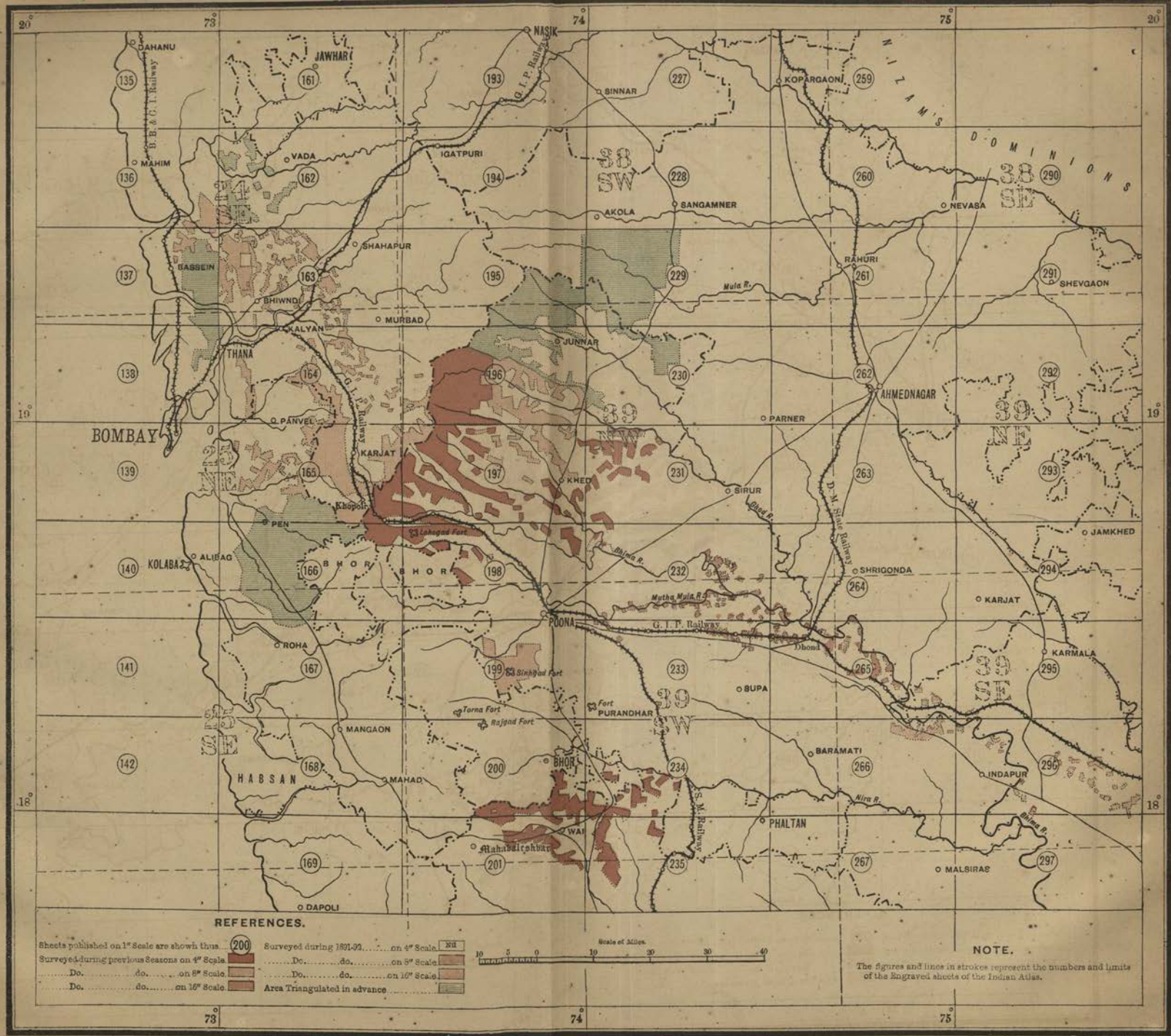
Reg. No. 555, S. I. D.—Mar. 98.—550.

Photo S. I. O., Calcutta.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN PORTION OF THE NORTHERN CIRCLE.

No. 17 PARTY.



REFERENCES.

Sheets published on 1" Scale are shown thus 200

Surveyed during 1891-92 ..... on 4" Scale Nil

Surveyed during previous Seasons on 4" Scale

..... Do. ..... do. ..... on 8" Scale

..... Do. ..... do. ..... on 16" Scale

..... Do. ..... do. ..... on 8" Scale

..... Do. ..... do. ..... on 16" Scale

Area Triangulated in advance

Scale of Miles.

10 5 0 10 20 30 40

NOTE.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

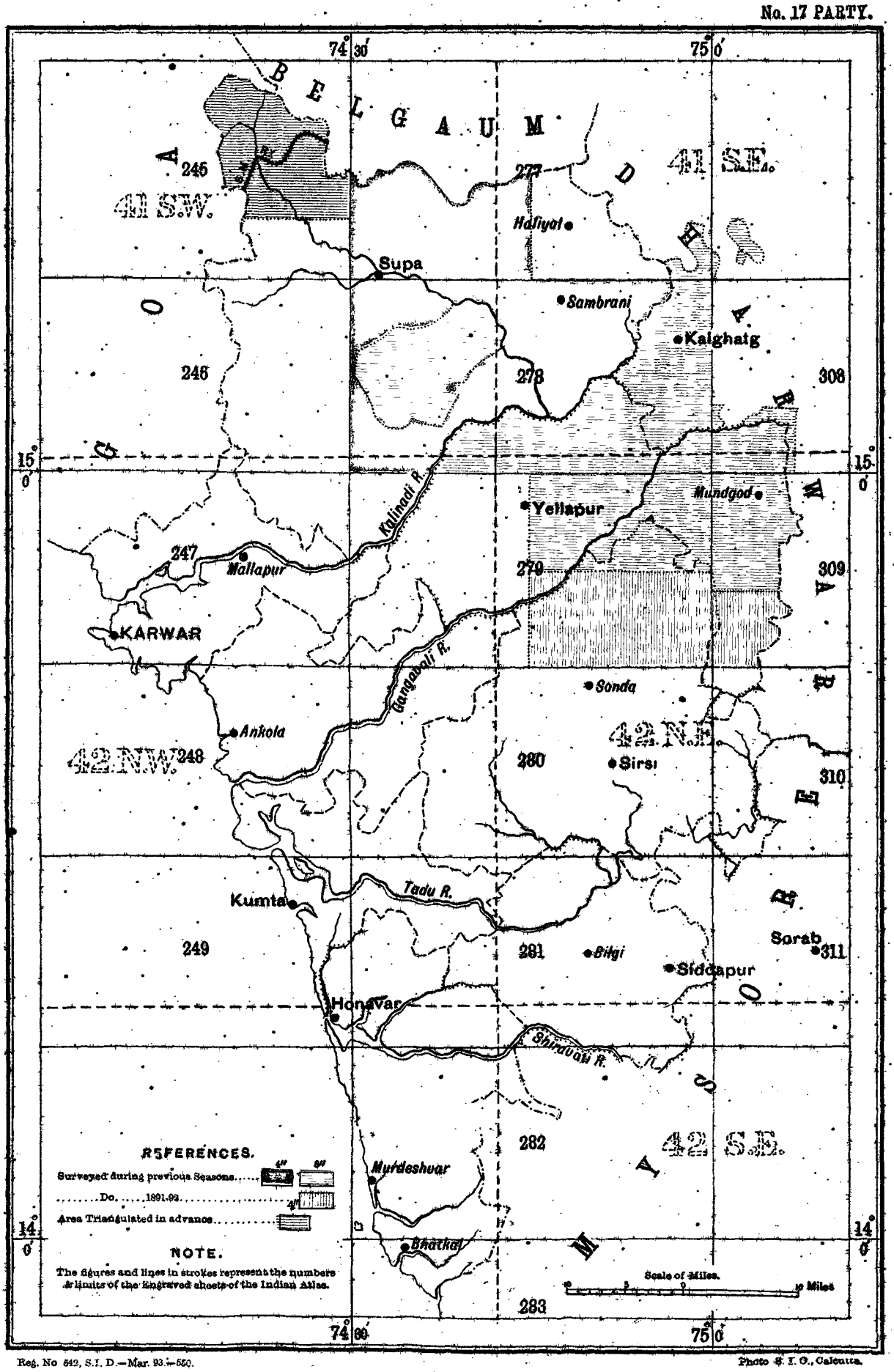
Reg No. 360. S. I. D.—Mar. 93—300.

Photo S. I. O., Calcutta.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SOUTHERN CIRCLE (N. KANARA).

No. 17 PARTY.



Reg. No 642, S.I. D.—Mar. 93.—550.

Photo S. I. O., Calcutta.

sections in sheets Nos. 23, 24, 34 and 35. Office copies of the triangulation charts of sheets Nos. 8, 9, 14 and 15 have also been prepared. Besides this, an index map of forest surveys in district Nimar was drawn in the office of the party and printed in the Trigonometrical Branch Office, Dehra Dun.

142. The computations of traverses and triangulation executed during the year have been finally completed. The General Report of the Hoshangabad and Betul Forests has been taken in hand and is making fair progress.

143. Four native military students have been with the party for the past two seasons and a fifth joined in September 1891. The first four men were employed on independent detail survey on the 4-inch scale; they have also been taught traversing with theodolite and route surveying, and before they go back to their regiments in April 1893 they will be further instructed in the use of the boiling point thermometer, the sextant, and the artificial horizon for time and latitude observations. They have also had practice in drawing, and two of them are neat draftsmen. The fifth man, who joined in September 1891, has been transferred to No. 11 Party from 1st October 1892.

144. The programme of work for the next field season is as follows:—

(*a*) The triangulation of about 500 square miles in district Nimar in sheets Nos. 6, 7, 12 and 13.

(*b*) Theodolite traversing over the ground to be triangulated.

(*c*) The detail survey of about 520 square miles in sheets Nos. 7, 8, 9, 14 and 15 in district Nimar, where triangulation was done last year.

(*d*) The classification of forest growth and soil of the area specified in (*c*).

145. The system of classifying forest growth and soil has been carried out by Colonel Wilmer in consultation with the Chief Commissioner, Central Provinces, and the Forest Officers of the districts of Hoshangabad and Betul. At present it is not known whether the Forest Officers of the Nimar district will require it. The Conservator of Forests has been written to on the subject, and the continuation of the classification in the Nimar district will depend upon the reply received.

146. Colonel Wilmer acknowledges his indebtedness to Mr. W. P. Thomas, Forest Divisional Officer, Hoshangabad, for assistance freely given to all members of the party.

147. The Officiating Surveyor-General and Deputy Surveyor-General in charge Trigonometrical Branch inspected the recess office of the party at Mussooree on the 27th September, 1892, and the following is an extract of his letter No. 2585, dated 4th October 1892:—

"I am glad to be able again to place on record my appreciation of the very efficient state in which I found your party at my recent inspection."*

BOMBAY PRESIDENCY.

No. 17 Party.

148. This party remained in the charge of Colonel Hutchinson throughout the year. The field operations were commenced early in October, 1891, and the work was restricted as before to the surveys of the forest tracts in the northern and southern circles of the Bombay Presidency.

Personnel.

Colonel H. S. Hutchinson, S.C., Superintendent, 2nd grade, in charge.

Mr. A. M. Lawson, Extra Assistant Superintendent, 1st grade.

Mr. S. F. Norman, Sub-Assistant Superintendent, 1st grade.

Mr. C. A. Norman, Sub-Assistant Superintendent, 1st grade.

Sub-Surveyors.

G. R. Bhopatkar, Gopal Vishnu, Gobind Gopal, R. V. Joshi, N. V. Bhopatkar, V. G. Bhat, Ramrao Yadhoo and 21 others.

149. The establishment was divided into three sections, which were supervised by Messrs. A. M. Lawson, S. F. Norman and C. A. Norman, respectively. The first section undertook the surveys on the 16-inch scale of *babul* reserves in

*Colonel Wilmer reports most favourably of all his European assistants, and makes special mention of the following members of the native establishment, *viz.*, Syed Zille Hasnain, Hydar Ali, Gurdutt Singh, Kadir Sharif, Karimdad Khan, Ram Singh, Mahadeo Daji, Sutto Charan Ghosal, Surjan Singh, Abdul Haq (1), Dharmu and Muhammad Zakaria, and military students Daffadar Fazaldad Khan and Lance Daffadar Dost Mohammad Khan.

the Bhima valley, Poona and Sholapur districts, and of the forest reserves in the Kanara district on the 4-inch scale. The second section was employed on 8-inch surveys of forests in the Bhiwndi and Bassein *talukas*, Thana district; and the third upon surveys on the same scale in the Panvel *taluka*, Kolaba district. In addition to these, an elaborate survey on the 8-inch scale of the Singhar hill in the neighbourhood of Poona was effected.

150. Section 1, under Mr. Lawson, commenced work on the *babul* reserves of the Northern Circle in the Bhima valley on the 10th October, and completed the survey on the 16-inch scale of 40 square miles by the end of December. The whole of this work was checked in the field by Mr. Lawson.

151. On the completion of the above work, Mr. Lawson proceeded to the Kanara district with eight sub-surveyors, to take up the 4-inch survey of the forest tracts of the Southern Circle, in continuation of the previous season's work. The operations were commenced on the 10th January, 1892, and continued up to the 10th April, during which time an area of 195 square miles was topographically surveyed in sheets Nos. 279 and 309. By this arrangement the unhealthy months in these tracts, *viz.*, November and December and the end of April and May, when heavy rain falls, were avoided, and a satisfactory out-turn accomplished without detriment to the health of the establishment. On the completion of the topography, Mr. Lawson was employed till the end of May in extending the triangulation and traversing in the Kanara district for the next season's detail survey, and an area of 100 square miles of country was thus prepared.

152. Section 2 was employed on the 8-inch survey of forests in the Northern Circle in the Bhiwndi and Bassein *talukas*, Thana district, and completed an area of 83 square miles, the work having been commenced early in November by Mr. S. F. Norman with six sub-surveyors.

153. Section 3 under Mr. C. A. Norman, with ten sub-surveyors, undertook the 8-inch work appertaining to the Southern Circle in Panvel *taluka*, Kolaba district, and commenced operations early in November. This ground had been prepared for survey two years previously; it was therefore imperative to take the detail survey in hand without further delay to prevent the loss of the survey marks. The area surveyed amounted to 68 square miles.

154. The 8-inch contoured survey of the Singhar hill was work of a special character, undertaken at the request of the local authorities to furnish a good map of ground close to Poona suitable for educational purposes in forestry. The preliminary triangulation was carried out by Surveyor Gopal Vishnu in October and November, 1891, and the detail survey, amounting in area to 51 square miles, was made in the months of April and May, 1892, under the supervision of Mr. S. F. Norman, by the establishment which had been employed in Kanara, and a few selected sub-surveyors from the Konkan. The hill is over 4,000 feet in height, and contour lines at 500 feet intervals were laid down with the aid of the clinometer. The work was carried out under the personal superintendence of Colonel Hutchinson, and a very accurate map has been obtained.

155. The Superintendent visited each of the several works in succession, and examined a percentage of survey in each locality. Every plane-table section was tested by European agency, either by rigid chain measurements or by *in situ* examination, and found to be on the whole accurate; the aggregate length of the check traverses amounted to 254 linear miles. Of the area triangulated, 100 square miles are in advance of the detail survey in the Southern Circle and 383 square miles in the Northern Circle for next season's work. Of the traversing effected, 104 linear miles are in advance in the Southern Circle and 237 linear miles in the Northern Circle.

156. The aggregate out-turn of work for the field season amounts to—

Triangulation		608	square miles.
Traversing		496	linear ,,
Topography, 16-inch scale		40	square ,,
Ditto, 8 do.		202	,, ,,
Ditto, 4 do.		195	,, ,,

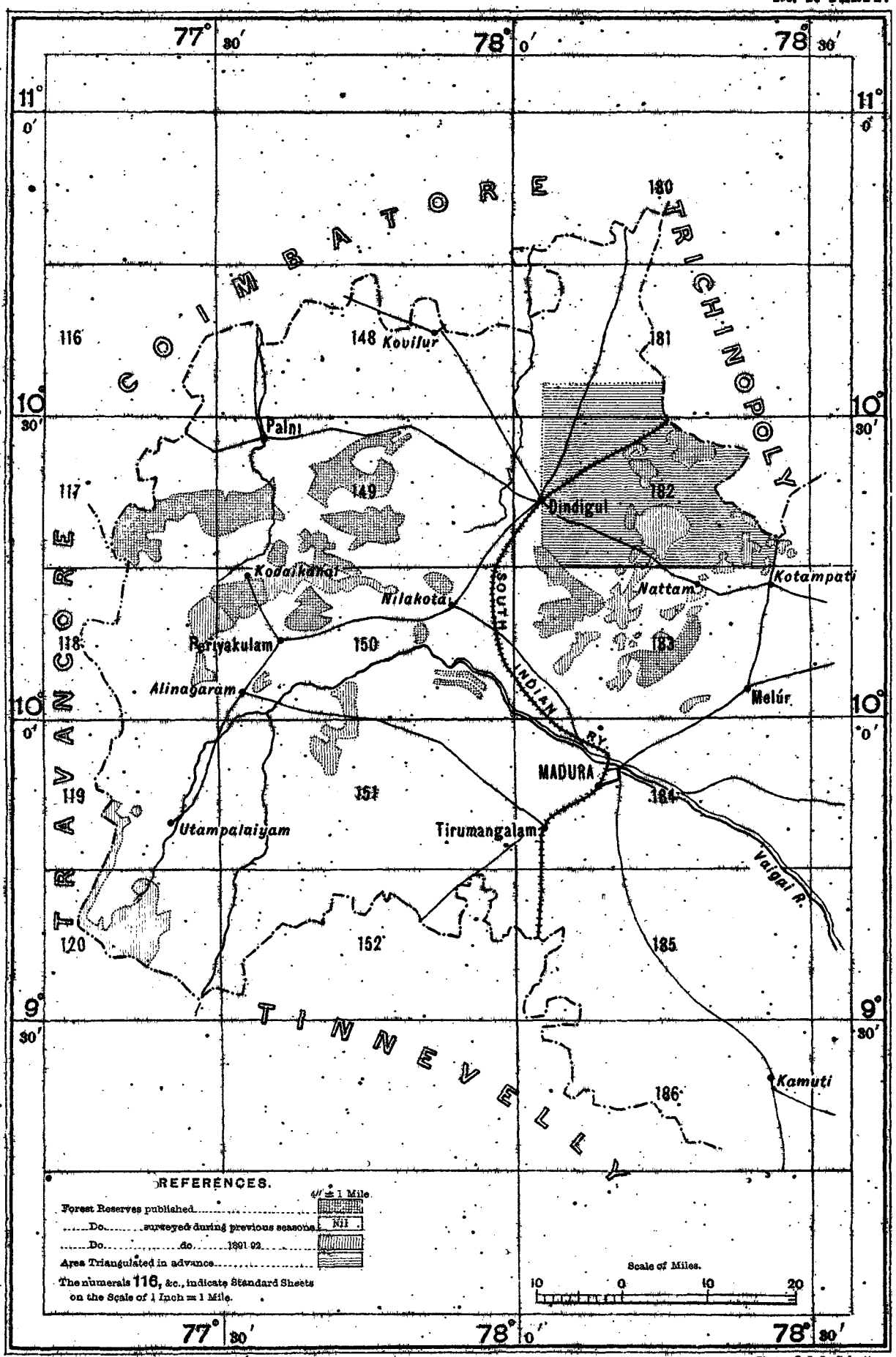
157. The cost-rates of the surveys, including triangulation and traversing, on the various scales are as follows:—

In the Northern Circle, for the 16-inch surveys ₹187 per square mile, and for the 8-inch surveys ₹178 per square mile. In the Southern Circle, for the

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE MADURA DISTRICT.

No. 19 PARTY.



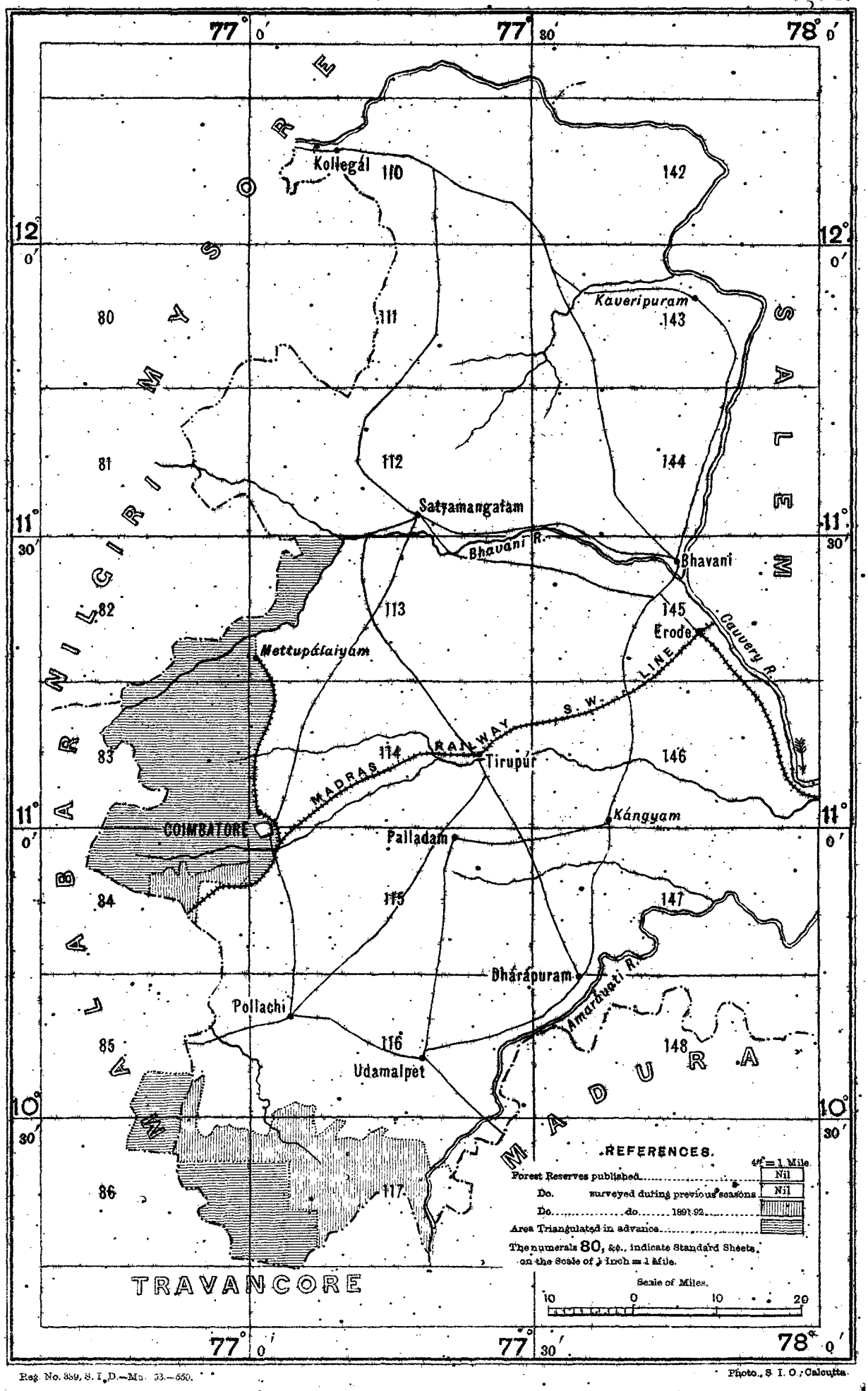
Reg. No. 338, S. I. D.—Mar. 93.—550.

Photo., S. I. O., Calcutta.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE COIMBATORE DISTRICT.

No. 19 PARTY.



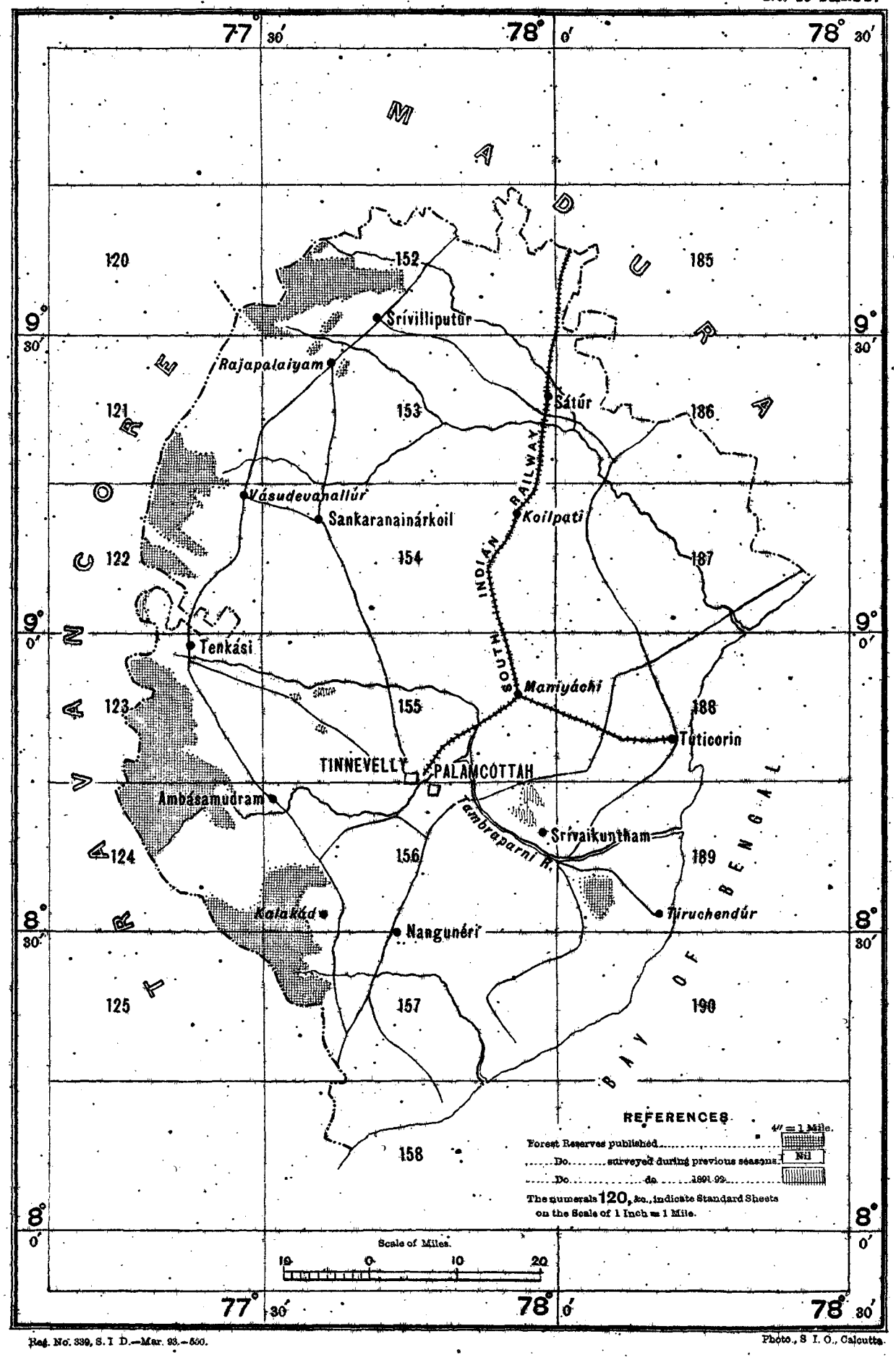
Reg. No. 359, S. I. D.—Mn. 33.—550.

Photo., S. I. O., Calcutta.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE TINNEVELLY DISTRICT.

No. 19 PARTY.



Reg. No. 339, S. I. D.—Mar. 93.—550.

Photo., S. I. O., Calcutta.

8-inch surveys R195 per square mile, and for the 4-inch surveys R126 per square mile.

The comparatively low rate for the 16-inch survey is due to the circumstance of the country operated in being quite flat and almost featureless.

158. During the recess, the mapping of the areas surveyed was completed and comprised the fair drawing of 104 standard sheets. A revised and extended index map for the Northern Circle was also prepared.

159. At the commencement of the season there was much fever amongst the men working in the Konkan, both in the Panvel and Bhiwndi *talukas*, especially in the former, and it was so bad at one time that the work almost came to a standstill. Matters, however, improved as the season advanced, and in the hot months in Kanara the health of the men was above the average of ordinary seasons.

160. The programme for the ensuing season comprises—

(*1*) *Northern Circle.*—The completion of the survey of *babul* forests in the Indapur *taluka*, Poona district, on the banks of the Bhima river (consolidating the work done last season, which is somewhat scattreed), and the commencement of 16-inch work on the Neera river; also the completion of the 8-inch forest surveys in Salsett, Bassein and Bhiwndi *talukas*, Thana district, and the commencement of similar work in Jaoli Bholeshwar in the Sangamner *taluka* of the Ahmednagar district.

(*2*) *Southern Circle.*—Surveys on the 4-inch scale in sheets Nos. 245 and 246, Kanara district, and the commencement of 8-inch surveys in the Pen *taluka*, Kolaba district. Advance triangulation and traverse will be executed in sheets Nos. 246 and 247.

161. The recess office of the party at Poona was inspected by the Officiating Surveyor-General in August, 1892, and found to be working very satisfactorily in all respects. The maps have been executed with much artistic skill, the records are carefully kept, and the work of the party appears to meet fully the requirements of the forest officials. The general reports of the triangulation and traversing are in a somewhat backward state, chiefly owing to the scattered nature of the operations of the party, but they will be taken in hand at once and brought into a condition suitable for permanent record in the Head-Quarters Office.*

MADRAS PRESIDENCY.

No. 19 Party.

162. This party has remained in the charge of Colonel McCullagh, R.E., throughout the year, and has continued the surveys on the 4-inch scale of the forest reserves in the Madras Presidency.

Personnel.

Lieutenant-Colonel J. R. McCullagh, R.E., Superintendent, 2nd grade, in charge.
Mr. C. F. Hamer, Extra Assistant Superintendent, 3rd grade.
„ H. Todd, Extra Assistant Superintendent, 3rd grade.
„ R. Todd, Sub-Assistant Superintendent, 1st grade.
„ T. J. J. Mills, Sub-Assistant Superintendent, 1st grade.

Surveyors and Sub-Surveyors.

T. Raghava Ayengar, Tiruvenkatsami Mudelliar, Lachman, D. Jadow, Balaji Dhondiba, Govindaraju Mudelliar, Ramasami Naidu, Anantarao Dhondiba, and 14 others.

163. The recess office was closed during the third week in August, 1891, when the different sections of the party moved to the various localities in which the survey operations were to be carried on, *viz.*, No. 1 section, under Mr. R. Todd, to the Coimbatore district, to continue the preliminary triangulation and carry out any traversing that might be found necessary; No. 2 section, under Mr. Hamer, to continue the detail survey of the reserve forests in Madura district, together with any supplementary triangulation and traversing that might be needed; No. 3 section, under Mr. H. Todd, to

* Colonel Hutchinson reports well of the work done by his assistants, Messrs. Lawson, S. F. Norman and C. A. Norman, all of whom had arduous duties to perform in a trying season. The native establishment is also well reported on.

commence the topography of the reserved forests in the Coimbatoredistrict; and a small detachment was told off to complete a small amount of work standing over in the Tinnevelly district.

164. Field operations were well in hand by the 1st of September and were continued till the first week of March 1892, when the party returned to recess quarters in Bangalore.

165. In Coimbatore, the triangulation was extended over the western portion of the district, while a part of the Anaimalai Hills left over from the previous year was also completed; it embraces an area of 1,000 square miles obtained by observations at 133 stations, from which 400 points and 391 heights were fixed. In Madura, the existing triangulation was extended over an area of 196 square miles by observations at 19 stations, whereby 84 points were fixed and an equal number of heights were obtained.

166. The traversing carried out during the season amounts to 253 linear miles. The small quantity of this class of work compared with the area topographically surveyed is due to the circumstance that the exterior boundaries of the reserves had in some cases been completely, and in others partially, surveyed by the Madras Survey Department, and the data having been obtained and utilized, the labour and expense of fresh traverse survey was thereby saved.

167. The area topographically executed amounts to 659 square miles, which is a satisfactory advance on that of the year before, and the largest outturn so far accomplished. The country operated in was in no way less difficult than that met with before, and the party experienced great difficulties in connection with the weather, as well as a large amount of sickness which prevailed more or less throughout the season. The result therefore is very creditable.

168. The country surveyed this season closely resembles that described in previous reports; it is for the most part very mountainous and very inaccessible, many of the hill-tops being as much as six and seven thousand feet above sea-level. In places also a dense forest growth was met with, rendering a correct representation of the ground a very ardous task to accomplish, and the nature of the country generally caused the arrangements in connection with supplies, labour, and carriage to be a matter of peculiar difficulty.

169. During the recess, the various computations have been brought up to date; and the fair mapping of the season's work has also been done, with the exception of a small portion coming into sheets which cannot be completed. The mapping is included in thirty-nine sheets and comprises 17 forest reserves in Madura made up of 56 blocks, 6 complete ones and a portion of a seventh in Tinnevelly, and about three-fifths of one very large forest and about one-sixth of another in Coimbatore as far as surveyed.

170. It is satisfactory to note that the cost-rate of the survey has this year been still further reduced, as the following statement, which gives the rate for final survey, including the cost of triangulation and traversing, will show:—

				R
In 1888-89,	cost-rate per square mile		. . .	162
„ 1889-90	ditto	ditto	. . .	149
„ 1890-91	ditto	ditto	. . .	112
„ 1891-92	ditto	ditto	. . .	97

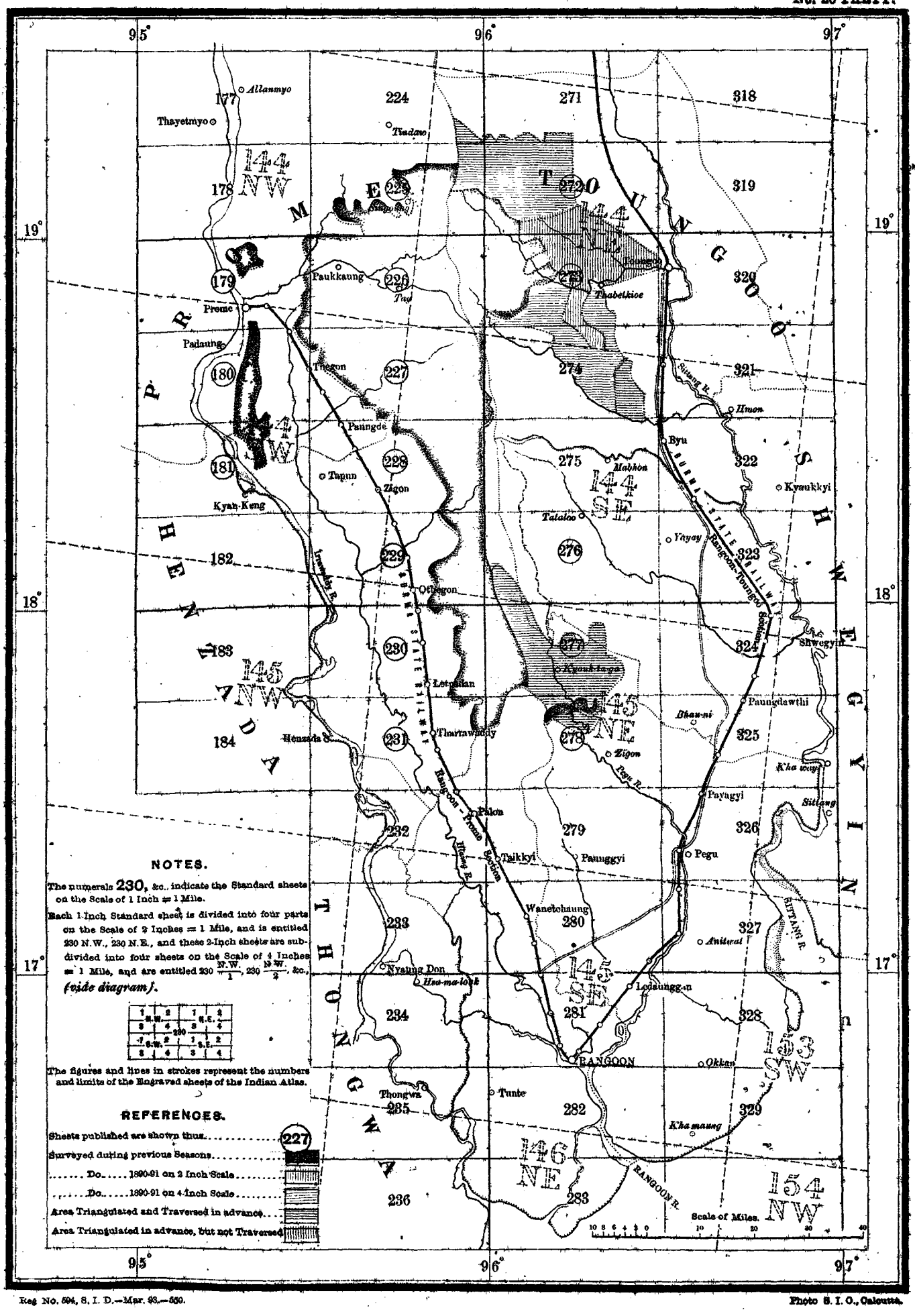
171. The Surveyor-General proceeded to Madras in April 1892 to inspect Colonel McCullagh's party and to confer with the local authorities regarding its operations. The Forest Member of the Board of Revenue and the Conservator of Forests were consulted and arrangements made for the future programme of work. The recess office of the party was inspected at Bangalore, and the results of the season's work carefully examined. The field maps were found to be carefully executed, and the professional and other records kept in thorough order, testifying to the efficient supervision which Colonel McCullagh maintains, and to which, with the aid of his assistants, the marked increase in the out-turn of work is attributable.

172. The programme for the ensuing season, which has been approved by the local authorities, comprises briefly the completion of the detail survey in Madura, and also, it is hoped, in Coimbatore; the commencement of

BURMA SURVEY.

INDEX TO THE FOREST SURVEY IN LOWER BURMA.

No. 20 PARTY.



NOTES.

The numerals 230, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2 Inches = 1 Mile, and is entitled 230 N.W., 230 N.E., and these 2-Inch sheets are sub-divided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled 230 $\frac{\text{N.W.}}{1}$, 230 $\frac{\text{N.W.}}{2}$, &c., *(vide diagram)*.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published are shown thus..... 227

Surveyed during previous Seasons.....

..... Do..... 1890-91 on 2 Inch Scale.....

..... Do..... 1890-91 on 4 Inch Scale.....

Area Triangulated and Traversed in advance....

Area Triangulated in advance, but not Traversed

Reg No. 504, S. I. D.—Mar. 93.—550.

Photo S. I. O., Calcutta.

topographical operations in Salem, where the triangulation will be resumed; and the starting of preliminary triangulation in the North Arcot district.*

LOWER BURMA.

No. 20 Party.

173. Mr. D'Souza held charge of the party throughout the field season and up to the 12th August, 1892, when he retired on a superannuation pension and was succeeded by Captain Fleming.

Personnel.

Colonel R. Beavan, S.C., Officiating Superintendent, 2nd grade, in charge up to 25th November 1891.
Mr. A. D'Souza, Officiating Deputy Superintendent, 1st grade, in charge from 26th November, 1891, up to 12th August 1892.
Captain J. M. Fleming, S.C., Officiating Deputy Superintendent, 1st grade, in charge from 13th August 1892.
Mr. W. A. Wilson, Extra Assistant Superintendent, 1st grade.
„ A. Barker „ „ 4th „
„ A. Ewing, Sub-Assistant „ 1st „
„ H. A. Charrier „ „ 2nd „

Surveyors and Sub-Surveyors.

Venkat Swamy, Abdulla Khan, Sharfuddin, Amjad Ali, Moung Kyaw Nyein, Moung Hpo Nyein and 20 others.

174. The party has been engaged, as heretofore, in carrying on the survey of forest reserves in the Toungoo district, on the scale of 4 inches = 1 mile, and of the enclosed unreserved tracts on the 2-inch scale.

175. The members of the party took the field early in December on the arrival of *khalásis* from India, and proceeded *vid* Toungoo to the work allotted to them. The topography of the Kabaung Chaung (left unfinished last year) and the Bhondaung reserves was first commenced, and in spite of a good deal of sickness at the start was completed about the beginning of April. A move was then made into the Pyu forest reserve, which had in the meantime been taken in hand by the traverse detachment of the party, and prepared for topography. Owing to the weather and sickness among the hands, it was found impossible to complete this reserved forest, and about 40 square miles remain to be done next season. On the termination of traversing in the Pyu forest, the traverse camp was moved to the north, and commenced work in the East and West Swa forest, which, with the enclosed Karen area, was traversed as far north as latitude 19° 15′ by the end of April, when it was found impossible to do more owing to the heavy rains which had set in.

176. The season's out-turn consists of triangulation over about 400 square miles of country, to furnish points by which to check the traverses. Traverse operations were carried on over an area of about 350 square miles, comprising a total length of chain-measured lines of nearly 640 miles. The detail survey covered an area of 227 square miles of forest reserve on the 4-inch scale, while an area of 68 square miles was completed on the 2-inch scale.

177. The field work was continued until the beginning of June, when the party returned to recess quarters in Rangoon. Owing to the early setting in of the rains, work was much retarded during the latter end of the field season, and the examination of several field sections has had to be postponed till next season. Most of the topography completed was tested by chain measurements, of which 86 miles were run through the various field sections: on the whole, the work was found accurate.

178. The latter part of the field season proved very unhealthy. Every member of the party suffered more or less from fever; and in the traverse camp, in particular, quite half the strength was unfit for work towards the close. Fever and dysentery were the chief complaints: six deaths occurred among the *khalásis*. All through the recess the fever contracted during the field season was constantly recurring.

* Lieutenant-Colonel McCullagh reports very favourably of his European assistants. Mr. Hamer worked his section with considerable success; Mr. H. Todd showed much zeal and ability in the direction of the section he had charge of; Mr. R. Todd was most energetic in prosecuting the triangulation in the face of considerable obstacles and much sickness among his men; Mr. Mills gave satisfaction in the way he carried out the miscellaneous duties entrusted to him.

The sub-surveyors generally are well spoken of, special mention being made of the good work done by Raghava Ayengar, Anantarao Dhondiba, Balaji Dhondiba and Eknath Battu.

The hospital assistant, J. Nathaniel David, is also commended.

179. The eastern portion of the country surveyed during the season is bounded by a long range of hills, rising very abruptly from the plains to the west of Toungoo, and extending from the Kabaung river on the north to the Pyu river on the south. The highest point on this range rises to a height of 1,512 feet. From about the centre of this range, another range having an average elevation of about 1,000 feet runs towards the Yomas in a north-westerly direction, and from this range again a series of small, low spurs extends to the northward. These are all densely jungle-clad, and the features are very intricate and difficult to survey. The hills throughout the country are all about the same height, and though the ridges are less densely wooded than the slopes, the country presents unusual difficulties to the triangulator. The most important streams are the Kabaung and Pyu rivers; both take their rise in the Yomas and fall into the Sittang river. The Pyu river has a very rocky bed and there are many waterfalls in its course. The Kabaung, on the other hand, has a broad, sandy bed, with only sufficient water during the winter months to float down bamboo rafts. In the rains, however, both become impetuous torrents and timber can then be floated down. Throughout the country travelling is very difficult, and the best way of getting about is by following the water-courses, or the tops of ridges where the jungle is less dense. The country is almost entirely uninhabited, except in the Karen tracts.

180. During the recess, the triangulation computations have been completed, and the results show fair agreement with those obtained by traverse. A certain amount of revision has unfortunately been found necessary in the previous season's traverse results, which has somewhat delayed the fair mapping of the current season's work. It is hoped, however, that seven standard sheets, on the 4-inch and two on the 2-inch scale, will be fair-mapped before the recess closes.

181. During the coming field season, it is proposed to undertake the survey on the 4-inch scale of that portion of the Pyu reserve left unfinished last field season, and also of the East and West Swa forest reserves, while the Karen area lying between the last-mentioned reserves will be mapped on the 2-inch scale. Should time allow, a portion of the Saing reserve will also be undertaken on the 4-inch scale. The advance triangulation and traversing will be carried on regularly to the northward, as far as the old frontier line between Upper and Lower Burma, in continuation of the present season's advanced work.

182. The party was inspected by the Deputy Surveyor-General during his tour in Burma in August 1892. Captain Fleming had but very lately taken over charge from Mr. D'Souza; the office records and books were all found in good order, and the field sheets had all been signed by Mr. D' Souza before he left. It was gratifying to see that the two best field sheets had been surveyed and drawn by Burman sub-surveyors. Directions were given to increase the amount of triangulation, the traverse work having been carried on too far during previous seasons without check. The nature of the country makes it very difficult to carry on regular triangulation, but Captain Fleming was directed to pay more attention to this in future*.

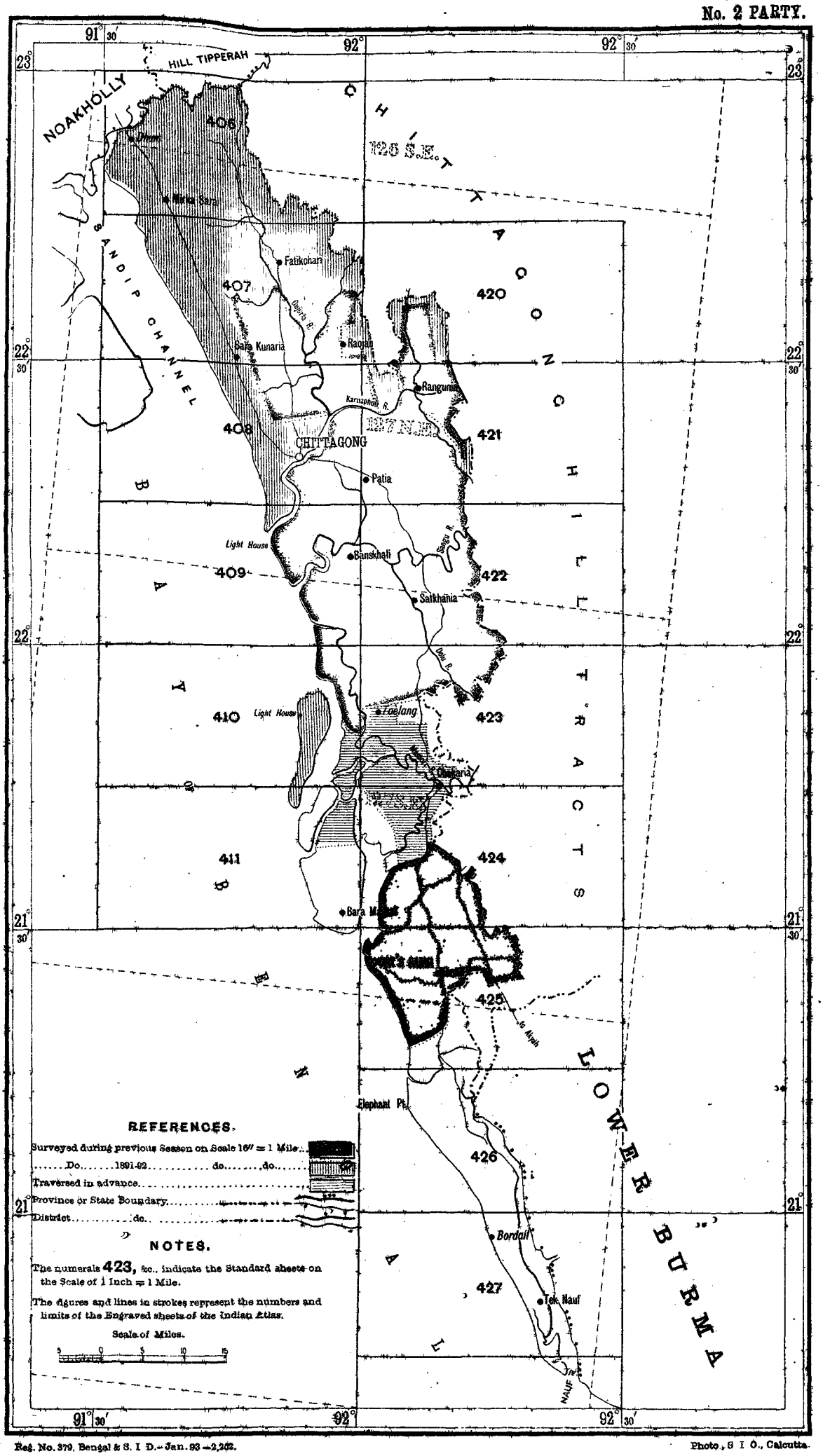
* Mr. D'Souza, who held charge of the party during the field season, reports as follows regarding his assistants :—

"Mr. W. A. Wilson has most ably and satisfactorily performed his duties. Mr. J. A. Barker has exercised a most careful supervision over all the members of his detachment; he is a hardworking assistant and regular in his attendance during recess". Mr. A. Ewing and Mr. H. A. Charrier are also well reported on; and the native establishment for the most part are said to have worked well.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT CHITTAGONG.

No. 2 PARTY.



REFERENCES.

Surveyed during previous Season on Scale 16″ = 1 Mile.....

.....Do.....1891-92.....do.....do.....

Traversed in advance.....

Province or State Boundary.....

District.....do.....

NOTES.

The numerals **423,** &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

5 0 5 10 15

Reg. No. 379, Bengal & S. I. D.—Jan. 93—2,262.

Photo., S. I. O., Calcutta.

CADASTRAL SURVEYS.

CHITTAGONG AND TIPPERA DISTRICTS, BENGAL.

No. 2 Party.

183. This party, of the strength shown in the margin, continued its operations in the Chittagong district and commenced the survey of the Chakla Roshnabad estate, district Tippera, belonging to the Maharaja of Hill Tippera, who made application for the survey under the provisions of the Tenancy Act. Mr. Grant, Officiating Deputy Superintendent, who had been recently granted a further extension of service to enable him to complete the survey of the Chittagong district, was compelled to retire in the beginning of July on account of ill health and handed over charge of the party to Mr. O'Sullivan.

Personnel.

Mr. F. Grant, Officiating Deputy Superintendent, 2nd grade, in charge from 2nd December, 1891, up to 11th July 1892.
„ W. J. O'Sullivan, Extra Assistant Superintendent, 2nd grade, in charge up to 1st December, 1891, and from 12th July 1892.
„ J. McHatton, Extra Assistant Superintendent, 4th grade.
„ C. G. Lee, Sub-Assistant Superintendent, 2nd grade.
„ M. F. Berkeley, Sub-Assistant Superintendent, 3rd grade.
11 sub-surveyors, etc.

Temporary Establishment.

1 supervisor.
155 field-surveyors.

184. Field operations were commenced in the Chittagong district on 1st November 1891; those in Tippera were begun about the middle of April 1892, when a small party was despatched from Chittagong to commence the preliminary traversing.

Survey of the Chittagong District.

185. The original programme for the field season comprised the completion of the survey of the Sadar sub-division only, but later by the orders of the Government, dated the 24th October 1891, the operations were extended to the rest of Cox's Bazar sub-division, old Thana Ramu having been previously surveyed and settled.

186. The traverse survey of the *thanas* of the Sadar sub-division was well advanced in season 1890-91, so that only 167 square miles remained, which were completed. In this area were included the very difficult portions of the boundary between Kumira and Mirsarai and Hathhazari and Phatikchari *thanas*. In Cox's Bazar 130 square miles of traverse survey were completed in Kutubdia and Mashkhal islands and in the cultivated area of Chakiria. The work in Mashkhal, however, was stopped after 20 square miles of traversing had been completed, as, with the exception of one village, it is stated to be permanently settled. The details of the out-turn of traversing are shown in the following statement:—

Sub-division.	Number of village circuits and sub-traverses.	Number of stations.	Area in square miles.
Sadar	629	13,603	167
Cox's Bazar			130
TOTAL	629	13,603	297

187. The detail survey on the 16-inch scale was commenced in November 1691 with 17 surveyors only. In December, 140 men were at work, but the strength was increased to 172 in January and to 189 in February 1892. Within the cultivated area all the *kittas* of fields (the unit of survey) were mapped, their average size being 0·13 of an acre. The boundaries of tea gardens were surveyed

in skeleton only, on the 16-inch scale, the interior details being omitted The following table gives the season's out-turn of detail survey :—

Sub-division.	Cadastral Survey. 16 inches=1 mile. Number of villages.	Number of fields.	Area in square miles.	Skeleton Survey. Area in square miles.
Sadar	428	2,194,393	462	177
Cox's Bazar	6	96,792	26	10
Total .	434	2,291,185	488	187

188. A survey of the Municipality of Chittagong was undertaken on the requisition of the Settlement authorities, and an area of 3 square miles was surveyed on the 16-inch scale and in the more densely populated portions on the 32-inch scale, but the work was then stopped pending the decision as to how the cost is to be met.

189. A survey of the hilly tracts on the 2-inch scale, based on a projection of the theodolite stations, was also undertaken. This part of the work caused the officer in charge great anxiety, as he had no trained topographical surveyors available to undertake it. But the survey was continued fitfully, and eventually, by the 15th June, 184 square miles were completed. Under the orders of the Government of Bengal no more surveys of the kind will be undertaken.

190. The cost-rate of the cadastral survey amounted to R171 per square mile; that of the skeleton survey to R92·5 per square mile; and that of the topographical survey of the hills on the 2-inch scale to R23 per square mile.

191. Of the settlement records, the areas of 297 villages of new work, containing 853,434 numbers, had been submitted to the Settlement Officer by the end of September 1892, and those of 171 villages, containing 463,099 numbers, were in hand, but the officer in charge hoped to submit these before the end of December 1892 without interfering with next season's work. Traces of all the new mapping have been submitted, except those of five villages which have been completed as far as possible, but cannot go in on account of changes made by the Settlement Department.

192. The officer in charge commends the establishment for remaining at their work while cholera was raging all over the area under survey during the latter months of the season. The casualties therefrom were 93, including one inspector and three *amins*.

193. The Director, Bengal Surveys, inspected the party in March 1892, and reports that Mr. O'Sullivan has done his best to meet the wants of the Settlement Department, but that under the current procedure it is impossible to make the work succeed.

194. The cadastral operations were closed by the end of May 1892. The weather during the season was fortunately most favourable, for there was really no bad weather till the setting in of the rains. The boundary skeleton survey and the hill topography was not completed till the 24th July 1892.

195. Mr. O'Sullivan complains of many difficulties due to the complicated procedure. He writes:—

"Owing to the order in which the sheets are received back, it is quite impossible to do more than complete them, as far as possible, and submit them, often, without comparing the boundaries.

* * * * * * * *

"It was not till July that all the sheets had been received back from the Settlement Office.

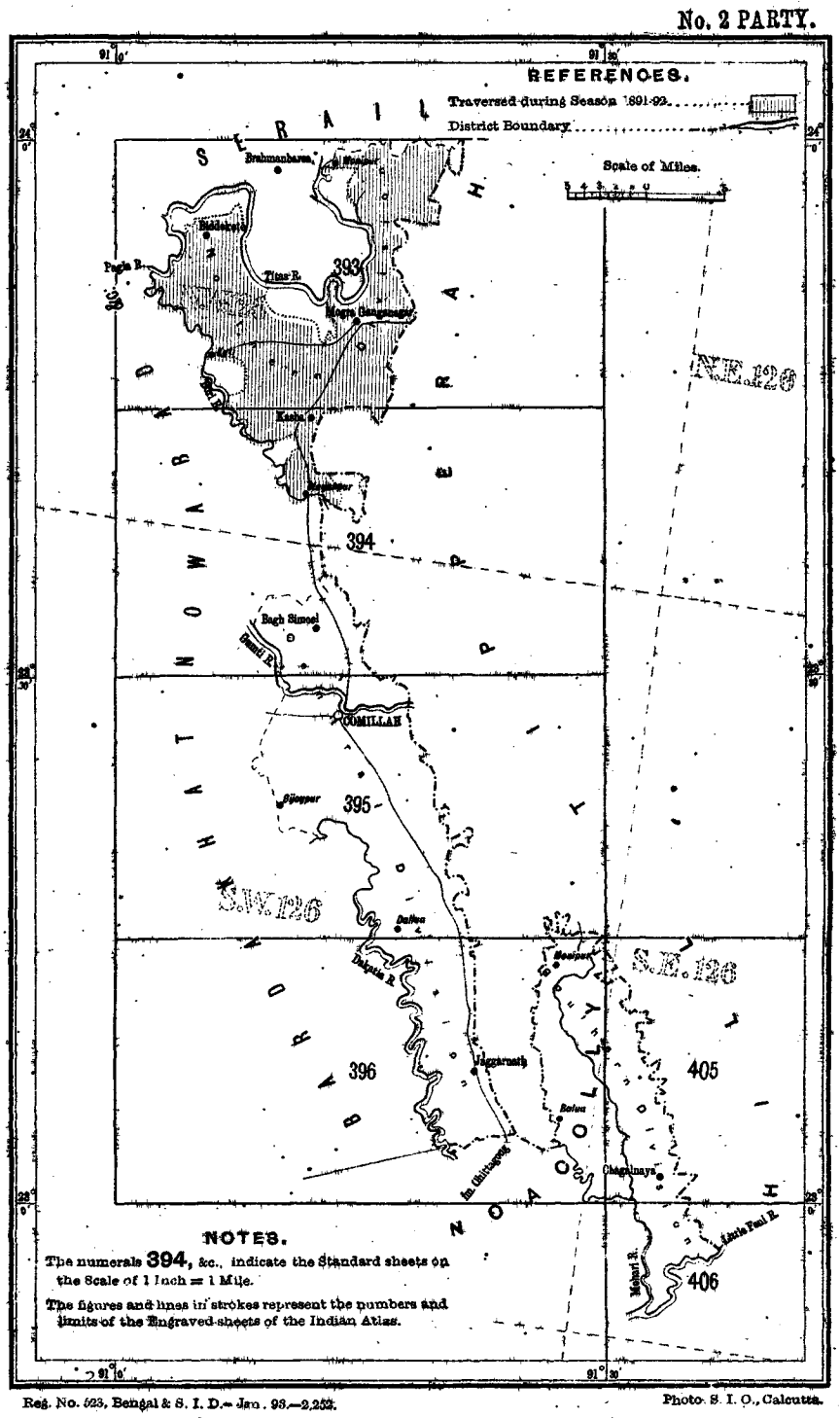
* * * * * * * *

"The comparison of boundaries having to stand over till the return of the sheets from the Settlement Department, has proved a source of great delay and expense. The orders of the Settlement Officer were that as soon as a sheet was finished it was to be sent on to

BENGAL SURVEY.

INDEX TO THE TRAVERSE SURVEY OF CHUKLA ROSHNABAD, DIST. TIPPERA.

No. 2 PARTY.



NOTES.

The numerals **394**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Reg. No. 523, Bengal & S. I. D.—Jan. 93.—2,252.

Photo. S. I. O., Calcutta.

him without delay, and this prevented any proper check being exercised either by the *partalling* or camp officer.

* * * * * * * *

"A large staff of *amins* had to be kept in to revise when necessary.

* * * * * * * *

"The chief cause of delay was the transfer of *chaks* from one village to another, which orders are often revised by the attestation officer months afterwards."

196. During the ensuing field season a detachment under Mr. O'Sullivan will complete the operations remaining to be done in Chittagong, of which the following is a summary:—

1. The cadastral survey of cultivation in Chakiria and Teknaf and in one village in Mashkhal, aggregating an area of 110 square miles.
2. The traverse circuit of the island of Mashkhal.
3. The 4-inch survey of the boundaries of all villages in Chakiria and Teknaf.
4. The traverse circuits of jungle tracts included in the original *patta* of a *taluk*, when the *talukdars* have cleared their boundaries.

It is anticipated that the field operations of the above work will be finished by April, and the completion of the maps and areas for the Settlement Officer will engage the detachment till October 1893.

Survey of the Chakla Roshnabad Estate, Tippera District.

197. This survey has been undertaken, under the provisions of the Tenancy Act, on the requisition of the Maharaja of Hill Tippera. The area of the estate is 572 square miles, of which about 10 square miles are situated in the Sylhet district. The area to be surveyed is thus 556 square miles.

198. Late in the season a small party was despatched from Chittagong to commence the preliminary traversing for a 16-inch cadastral survey. Comilla was reached on 15th April 1892, and operations commenced shortly after in *pargana* Nurnagar, in the northern division of the estate, as being most convenient. During the first month practically nothing was done, for the people declined to point out their boundaries. The *talukdars* held aloof, and no list of them could be obtained from the estate authorities, although applied for several times. At length, on the 31st May, the Collector visited the survey camp and personally explained the objects of the survey to the *talukdars*, after which matters mended.

Personnel.
Mr. J. MacHatton, Extra Assistant Superintendent, 4th grade.
Ten sub-surveyors.
Seven computers and draftsmen.

199. In the absence of all demarcation, the villages were traversed as pointed out, the surveyors being supplied with the Collector's registers and with copies of the old 4-inch map to help them. In these latter, all villages are not shown as separately measured, but several are grouped together under one *thak*. They have now been separated. The particulars of the out-turn of traverse survey are shown in the following statement:—

	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Chakla Roshnabad estate . . .	351	306	5,225	150

200. Notice was given of 19 disputes on boundaries, which will be disposed of as the cadastral survey proceeds. A number of petitions were received by the officer in charge from the *talukdars*, which consist for the most part of objections to have their *taluks* measured in different *mauzas*. But this cannot be avoided while the *mauza* is a recognized local unit, which there can be no doubt it is.

201. Great difficulty was experienced in connecting the work with that of *pargana* Sarail, which was surveyed in 1889-91 as it was found that all the stone marks, which had been embedded by the surveyors along the northern bank of the Pilas river in 1889-90, had been uprooted and thrown away; at least this is

the supposition: an enquiry will, however, be made. The *zamindars* are responsible for the maintenance of these marks under the Survey Act, and should be called to account if such is the case. The Act appears to be defective, and there is no section that actually applies in such circumstances, although the Act was doubtless framed for the purpose.

202. The tract which has been under survey is a low-lying flat plain, bounded on the east by the Tippera hills, on the north by the Pilas river, and on the west and south by the Buri river. It is subject to inundation during the rains by the overflow of the rivers. One of the features of the country is the existence of occasional large *bils*, the edges of which are cultivated by a coarse kind of paddy called *boro dhan*. The soil is exceedingly fertile, the staple crop being paddy.

203. The cost of the operations has been R14,575 which is very high, but R1,560 were spent on instructing local cadastral establishments. It is due to the causes already mentioned as having impeded the work, but also to the inexperience of the traverse surveyors, which might be avoided if establishments were not so often broken up and dispersed, so that there are few theodolite surveyors of experience left who can show a really good out-turn.

204. The Collector did his utmost to arouse the people to assist the surveyors, and called upon the *chaukidars* to submit weekly reports on the state of preservation of the theodolite stations, as it was too late in the season to imbed permanent marks. Babu Hemendra Nath Roy, the Sub-Manager of the northern division, also gave substantial aid.

205. The detachment left the field for recess quarters at Comilla on the 11th July.

206. It is anticipated that the arrangements which have been made for the next season's work will result in comparatively low cost-rates, if Mr. MacHatton's management is good. In the northern division 54 square miles remain to be traversed; as this area chiefly consists of *bils*, it is not expected that the water will subside sufficiently to allow of the traverse operations being begun till February. In the central division 228 square miles and in the southern division 124 square miles remain for traverse survey.

207. A survey training school for local men was opened at Comilla on the 10th April 1892, and by the end of September 200 men had been trained and 100 more were under instruction. These men will survey and write the records and gradually supplant the Hindustani *amins* who have been imported. As the Maharaja of Hill Tippera has requested for various reasons that the cadastral operations should be prolonged over at least two seasons, only 300 square miles are to be surveyed during 1892-93 and the remaining 256 miles in 1893-94.*

* Mr. O'Sullivan reports that credit is due to Mr. MacHatton for the work accomplished by him under difficult circumstances. Mr. C. G. Lee is said to have worked with untiring energy, and Mr. F. Berkeley promises well. Of the subordinate establishment employed in the Chittagong district, the following are specially mentioned :—

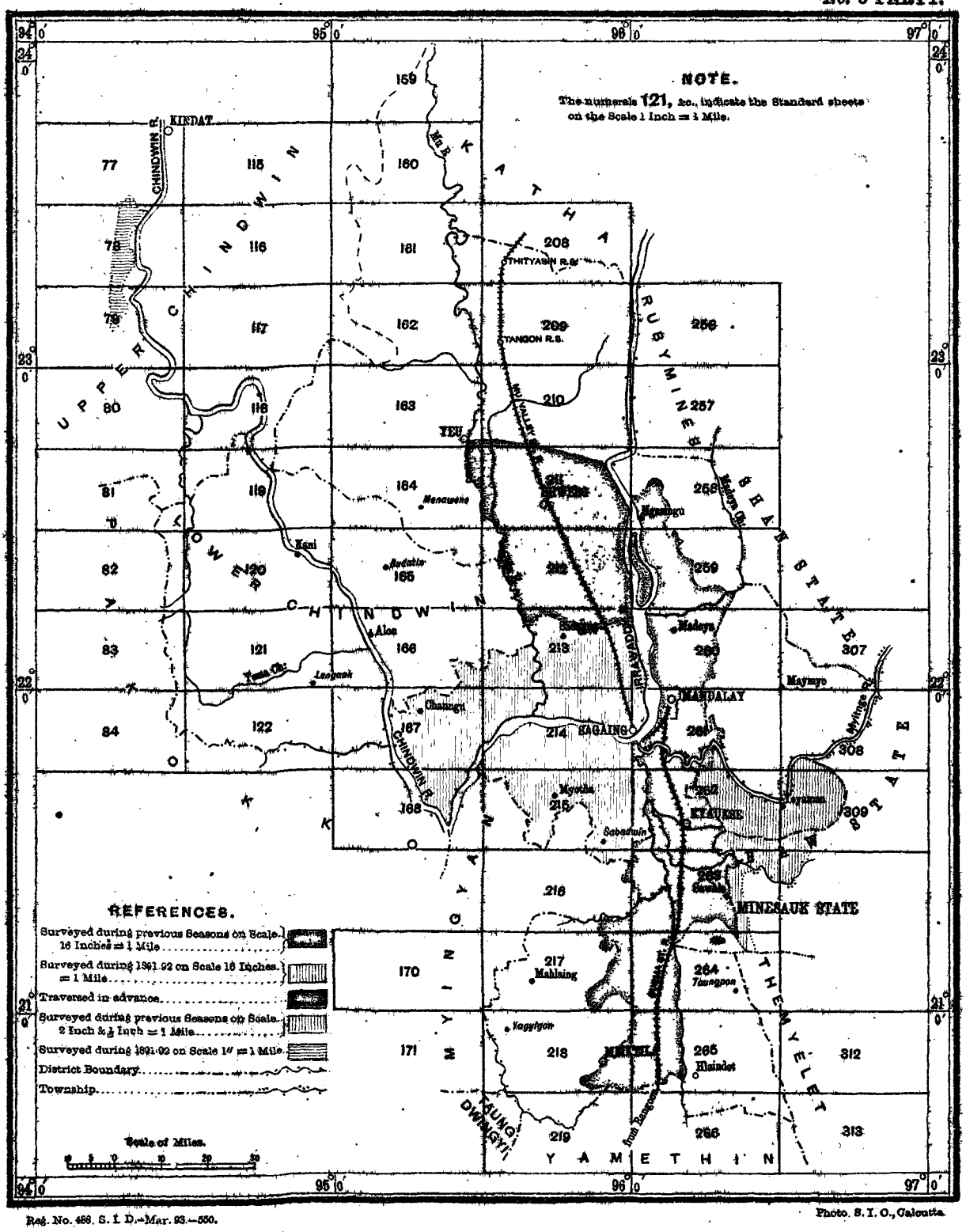
Mr. McIntyre, Babu Ramji Lall, Binda Lall, Narain Prashad, Hamil Husain, Augamothu, Ram Narain, Candaswamy, Israr Husain, Abu Mahomed, Basit Ali and Kampta Pershad.

The traverse surveyors employed in the Tippera district are unfavourably reported on by Mr. MacHatton, but he states that the computers have worked well.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. SAGAING, SHWEBO, MANDALAY, MEIKTILA, & KYAUKSE.

No. 3 PARTY.


NOTE.
The numerals 121, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.
94° 0′
95° 0′
96° 0′
97° 0′
24° 0′
23° 0′
22° 0′
21° 0′
KINDAT
CHINDWIN R.
UPPER CHINDWIN
KABAW VALLEY
MYITHA R.
THITYASIN R.S.
TANGON R.S.
YEU
RUBY MINES
SHAN STATES
KYAUKSE
MINESAUK STATE
THEMYELET
YAMETHIN
MEIKTILA
MANDALAY
SAGAING
Monywa
Kani
Alon
Ye-u
Shwebo
Kyaukse
Sabaduin
Mahlaing
Yaungbyon
Tatkon
Meiktila
Thazi
Nyaungu
Madaya
Maymyo
Myingyan
Yenangyaung
Singu
Pyawbwe
Tharsi
Kyaukpadaung
Nyaungbaw
Pakokku
Myaing
Yenangyat
Salin
Pauk
Magwe
Minbu
Thayetmyo
Sinbaungwe
Gangaw
Tilin
Sale
Natmauk
Yenangyaung
Chauk
Salin
Pakokku
Myaing
Yenangyat

SAGAING DISTRICT, UPPER BURMA.

No. 3 Party.

208. The programme of work of this party comprised the cadastral survey of the Sagaing district, advance traverse work in the Shwebo district, and the topographical survey on the 1-inch scale of a portion of the coal-bearing tract in the Upper Chindwin district. The strength of the party is given in the margin.

Personnel.

Mr. G. B. Scott, Deputy Superintendent, 2nd grade, in charge from 21st December 1891.
„ B. G. Gilbert-Cooper, Assistant Superintendent, 1st grade, up to 16th May 1892, and in charge up to 20th December 1891.
„ J. Connor, Extra Assistant Superintendent, 3rd grade.
„ J. Newland, Extra Assistant Superintendent, 4th grade, up to 16th March 1892.
„ O. D. Smart, Sub-Assistant Superintendent, 1st grade.
„ P. J. Serrao, Sub-Assistant Superintendent, 2nd grade.
„ F. P. Walsh, Sub-Assistant Superintendent, 2nd grade.
„ W. J. Baker, Sub-Assistant Superintendent, 2nd grade.
„ H. B. Powell, Sub-Assistant Superintendent, 3rd grade.
24 surveyors, sub-surveyors and others.

Temporary Establishment.

16 inspectors.
160 field surveyors (Indian).
32 ditto (Burman).

209. Field work commenced in Sagaing about the 20th November 1891, and closed on the 20th June 1892, when the party returned to recess quarters in Mandalay.

210. The demarcation of Sagaing district had been carefully completed, and tracings of plans showing *taiks* or circles, and *kwins* or villages, were made over to the survey office before the party took the field. The demarcation in Shwebo had only just been commenced when traverse operations began in that district in April; consequently only circle boundaries as laid down by *thugyis* could be traversed, but a sufficient number of sub-traverses were run to allow of the *kwin* or village boundaries being correctly plotted by the *amins* during next season, by which time it is hoped the plains portion of the district will have been demarcated.

211. In the Sagaing district, 15,342 theodolite stations have been marked by baked clay cylinders about two feet in length, which, with those fixed last season, make a total of 20,724 permanently marked stations: in Shwebo, 11,995 stations have been marked in the same manner. Arrangements are being made to procure glazed clay cylinders at Kyoukmyoung on the Irrawaddy for future use in the Shwebo district. The Deputy Commissioners of the districts have been asked to arrange for the preservation of these marks in accordance with the Burma Boundaries Act. Where the Chindwin and Irrawaddy rivers touch on districts Lower Chindwin, Pakkoko and Myingyan, both banks of the rivers were enclosed by traverse lines, the stations being permanently marked. Plots were sent to the respective Deputy Commissioners to assist them in identifying and preserving the stations.

212. The total area traversed in Sagaing this season was 1,219 square miles, which, with 714 surveyed last season, gives a total of 1,933 square miles; but of this, 101 square miles are river circuits, and of these again 40 square miles lie in adjoining districts. There were 3,582 linear miles of chaining run in Sagaing district and 2,866 in Shwebo district, double sets of chains being used throughout, as in last season. The angular work was checked by 71 azimuth observations in Sagaing district and 56 in Shwebo district. Two stations of the Great Trigonometrical Survey were connected with the traverse work in Sagaing district, *viz.*, Mozataung in the south and Mingun in the north, which furnished checks to the linear measurements. The positions of 103 conspicuous objects, chiefly masonry pagodas, have been connected with the traverse lines by theodolite observations.

213. The theodolite at every station was set up in the magnetic meridian; by doing this, not only can any large angular error at once be discovered, but a close approximation to the magnetic variation at each village at the time of survey can be obtained. The magnetic readings, which are taken with greater accuracy at each of the azimuth stations, vary considerably in the four districts of Kyaukse, Mandalay, Meiktila and Sagaing.

Thus in Kyaukse they varied from 4° 54′ to 1° 25′; on Mandalay from 4° 57′ to 1° 30′; in Meiktila from 3° 21′ to 1° 32′; and in Sagaing from 3° 50′ to 1° 32′. With a view to ascertaining how much of this is due to local attraction and how much to instrumental errors, the magnetic variation has been determined with each instrument when erected on the same spot, and the differences from the

mean have been noted. It is intended to apply these to the observations made during the coming season.

214. The total out-turn of work for the season is shown in the following table :—

Districts.	Cadastral Survey, 16 inches = 1 mile.			Traverse Survey.		Topographical Survey 1 inch = 1 mile.
	No. of villages.	No. of fields, etc.	Area in square miles.	No. of village blocks.	Area in square miles.	Area in square miles.
Sagaing	1,150	1,001,010	1,818	691	1,219	...
Shwebo	...	...	...	364	800	...
Upper Chindwin . .	...	...	...	...	...	106
Total .	1,150	1,001,010	1,818	1,055	2,019	106

The cadastral area, *viz.*, 1,818 square miles, excludes all rivers; the high banks of these have been surveyed by the plane-table throughout, as well as all islands, cultivated or otherwise. The small groups of hills lying within the area surveyed on the 16-inch scale have been surveyed on the 2-inch scale.

The total number of items surveyed was 1,001,010, the average size being about 1·16 acre, but if all large blocks of jungle, etc., are omitted, the average size of the "field" is about 0·64 of an acre. It is impossible, till a statistical statement has been prepared, to say what proportion the cultivated area bears to the uncultivated, but judging from results already obtained, it will probably be about 40 per cent. The statistical statements for districts previously surveyed have now been prepared, and the results are as follows :—

Kyaukse,	under crops and fallow	. . .	59%	of area surveyed.
Mandalay,	ditto	ditto . . .	46%	ditto.
Meiktila,	ditto	ditto . . .	55%	ditto.

This should, of course, be considered when comparisons of costs are made. The uncultivated portions are covered with thorny scrub, and when near hills are broken by numerous ravines.

215. The Irrawaddy, Chindwin and Mu rivers, which flow through or on the boundaries of Sagaing district, have usually high firm banks and seldom overflow. But the water of the Irrawaddy, when the river is full, flows up the beds of water-courses that fall into it from the hills, and fills large depressions, thus forming little lakes, or *ins*, round which rice is raised in large quantities. Advantage is taken of the slopes of hills and downs to make small dams to collect the rainfall, and from the tanks or *kans* so formed, water is gradually let off over the neighbouring low lands for irrigation. This method might be extensively enlarged when the population increases. At present the bulk of the crops are cotton, sesamum and *jawar*, not needing irrigation. A Chinaman collects large quantities of cotton at Ywathitgyi, on the Irrawaddy, chiefly for the Chinese market, *viâ* Bhamo.

216. The average cost of the cadastral survey, including the permanent marking of stations, traverse, detail survey and mapping, as well as tracings and area statements for the Settlement Department, was ₹141-4 per square mile, or As. 3-6 per acre, as against As. 4-11 per acre in Mandalay last season and As. 8-5 per acre in Kyaukse in 1889-90. This reduction in the cost-rate is due to the large area surveyed and to the larger employment of local labour. The employment of village coolies in place of *khalásis* imported from India has effected a saving of nearly ₹21,000, due to not having to pay the passages of *khalásis* to and from India, and to the difference between their regular monthly pay and the amount actually paid for local labour. It is possible that a further saving may be effected next season by extending the employment of local men; but as other departments pay higher wages, and a better season for crops may make the people less inclined to work for wages, it is not safe to trust entirely to local labour.

217. Regarding the employment of Burmans as sub-surveyors and *amins*, Mr. Scott reports as follows:—

"It is to be regretted that the employment of educated Burmans as sub-surveyors and *amins* cannot also be largely increased, but there is too much uncertainty about them to allow of a complete reliance being placed on them."

Four Burman surveyors were employed throughout the season; the out-turn of one of them was as good as that of the best of the Indians, and two others did well, but the fourth was useless. Thirty-two Burman *amins* were employed, two with each Indian squad, and on the whole did well, though their out-turn was not so large as that of most of the Indians. A large number of Burmans are now employed in the mapping, tracing, and area estimating sections.

218. The traverse work in Sagaing was completed by the beginning of April, and the camp was transferred to Shwebo. The cadastral survey of the entire district was completed by the middle of June, and tracings and area statements of about 800 villages are now ready for submission to the Settlement Officer: the rest will be ready by the close of the recess season. Three thousand linear miles of check survey were run in field books, and 1,350 linear miles on plane-tables while work was in progress, to test the accuracy of the survey, and the work proved to be very good. Every village was checked by a final field book *partal* before being passed.

219. The health of the party in Sagaing was exceptionally good; not a single death occurred. In the coal tract one *tindal* died. The hospital assistant in Sagaing, Gunga Churn Guha, performed some skilful operations for broken limbs, and the dispensary was highly patronised.

220. A detachment under Mr. Newland was sent to survey a tract of coal-bearing country in the Upper Chindwin district, and to demarcate a block for the Buckland Syndicate. As the area at first proposed for survey was very large, the establishment sent was a strong one: this area was subsequently reduced to 106 square miles; but as the country was a mass of hills rising to three thousand feet, quite uninhabited and covered with dense forest, the *khalásis*, in addition to jungle-cutting, had to carry their own supplies by relays across the hills from the Chindwin river, and thus a smaller party might have failed to do the work required. Mr. Newland was prostrated by fever shortly after arrival on the ground, and Mr. Walsh was sent to help him: he also was taken seriously ill. However, both recovered for the time, and the work was completed by the middle of March. The triangulation was based on four points of the Kubo and Chindwin Valleys Series. The Deputy Superintendent visited the place in January, and spent a week in placing the work on a proper footing. Unfortunately Mr. Newland died of heart disease on the 16th March. In him the Department has lost a most experienced, devoted and trustworthy officer.

221. The relations with the Civil authorities were cordial throughout the season, and those between the survey employés and villagers were, as a rule, most friendly. An extract from Mr. Scott's narrative report on the country surveyed will be found in the appendix.

222. The programme for next year comprises the cadastral survey of all open country in Shwebo district, probably 1,200 to 1,400 square miles, the traverse of Yeu district in advance, and the laying down of a small section of disputed boundary between Manipur and Burma.

223. On the 22nd August 1892, the Deputy Surveyor-General met the Chief Commissioner at the survey office at Mandalay, and inspected the maps and discussed the future programme of the party with him. A detailed inspection was afterwards made by the Deputy Surveyor-General on the 22nd and 23rd August, when everything was found in excellent order. The large out-turn and low cost-rate testify to the good management and energy of Mr. Scott.

224. Mr. Gilbert-Cooper held charge of the traverse camp for a time; he was also sent to run a series of check lines across the Ava sub-division, after which he was instructed in the various computations required in a cadastral party. He is a promising assistant.*

* Mr. Scott reports thus of his assistants: "Mr. Connor, who held charge of the cadastral camp throughout the season, and Mr. Smart, who held charge of the traverse camp after Mr. Gilbert-Cooper's departure, both did excellent work. Messrs Serrao, Baker and Powell all worked with zeal and ability, and aided largely in the progress of the work. Mr. Walsh has been employed chiefly on hill work, and has, as usual, been most willing to perform any work allotted to him, however arduous."

Of the natives, he selects the following as specially deserving of notice, *viz.*, Bhugobutty Charan Chuckrabutty, Pandit Kedar Nath, Gafur Bux, Masiuddin, Alimuddin, Moung Pho Tun, Abdul Hassan, Rafartulla, Rangbehari Lall and Mahomed Shaffi.

WESTERN DUARS, BENGAL.

No 4 Party.

225. This party has been employed on cadastral and topographical operations in the Western Duars in continuation of the work of former seasons, the latter comprising the survey of reserved forests on the 4-inch scale and of the waste lands on the 2-inch scale. The re-laying of the Jalpaiguri-Bhutan boundary was also continued and completed.

Personnel.

Captain G. B. Hodgson, S.C., Deputy Superintendent, 2nd grade, in charge.
Mr. H. T. Hanby, Extra Assistant Superintendent, 2nd grade.
„ W. H. Penrose, Sub-Assistant Superintendent, 1st grade.
„ G. T. Hall, Sub-Assistant Superintendent, 1st grade.
„ G. A. Knight, Sub-Assistant Superintendent, 1st grade.
„ L. F. Berkeley, Sub-Assistant Superintendent, 1st grade.
„ P. C. H. Smart, Sub-Assistant Superintendent, 1st grade.
„ C. G. S. Wood, Sub-Assistant Superintendent, 2nd grade.
„ P. K. Vaughan, Sub-Assistant Superintendent, 3rd grade, from 23rd November 1891.
43 sub-surveyors and others.

Temporary Establishment.

84 field surveyors, inspectors, etc.
62 computers, draftsmen, etc.

Cadastral Survey.

226. The cadastral operations consisted principally in the preparation of the records of the former year's survey for the Settlement Department, the work being considerably in arrears, as explained in former reports. A few detached plots of land were surveyed cadastrally, which had been omitted in former seasons or which had recently been allotted.

227. The divisions into which the lands are separated was given in para. 204 of the General Report for 1890-91, and is again quoted as it explains the "unit of the map" in the Duars:—

"The only territorial divisions bearing definite names in the Western Duars are *parganas* and *talukas*; the latter are sub-divided into plots of various sizes called *jots*, which are distinguished by the name of the tenant (*jotdar*), or of his successor, and by serial numbers called *tauzi* numbers. The *taluka* is too large, and the *jot* too small, to serve as a survey unit, so it was decided to club together several *jots*, so as to make up areas approximating to the size of the *mauza* or village in the North-West Provinces, and to treat them as the unit for the traverse survey, but the *jot* is the unit recognised for settlement purposes. These blocks of congregated *jots* are called *chaks*, which have been numbered consecutively for each *taluka*."

228. It was anticipated that only 5 or 6 square miles of the cadastral survey of some *jots*, which had been omitted in previous seasons for various reasons, remained for survey; but as the work progressed it was found that new *jots* had been formed out of the jungle, so that the area for survey gradually increased, and amounted in the end to 22·74 square miles, which were completed and the details of which are tabulated below:—

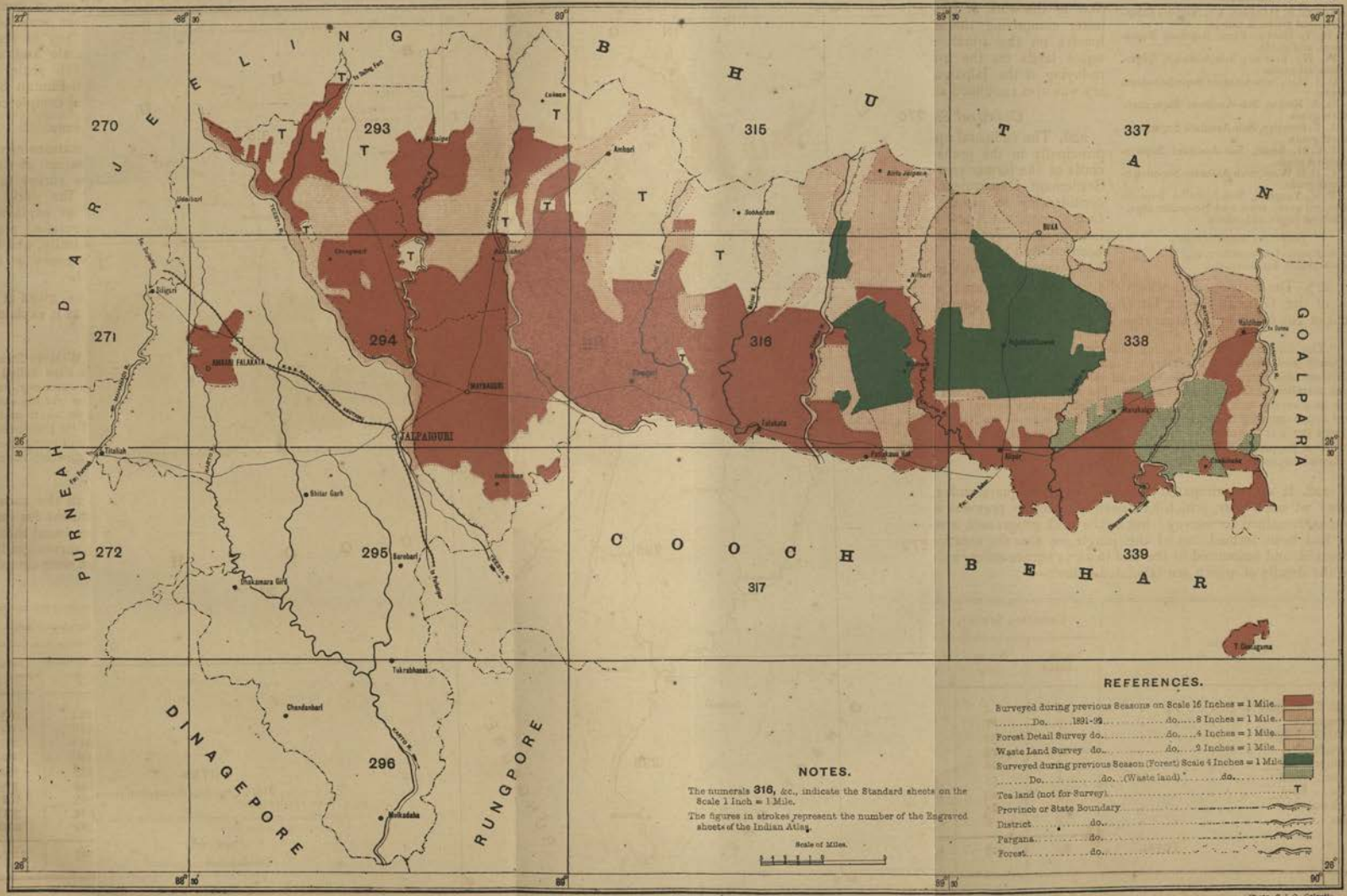
Parganas.	Cadastral Survey, 16 inches=1 mile.			
	No. of *chaks*.	No. of *jots*.	No. of fields proper.	Area in square miles.
South Mainaguri	2	4	214	0·35
Chengmari	7	17	916	1·47
North Mainaguri	12	39	940	2·37
Moraghat	10	29	446	1·28
Lakhipur	7	28	535	1·48
Madari, West	4	55	825	5·55
Do., East	17	23	1,095	6·21
Chakwaheti	...	25	524	3·11
Buxa	8	8	302	0·92
Total	67	228	5,797	22·74

The average size of fields in district Jalpaiguri has this season been found to be 2·51 acres.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE WESTERN DOOARS (DISTRICT JALPAIGURI).

No. 4 PARTY.



REFERENCES.

- Surveyed during previous Seasons on Scale 16 Inches = 1 Mile.
- Do. 1891-92 do. 8 Inches = 1 Mile.
- Forest Detail Survey do. do. 4 Inches = 1 Mile.
- Waste Land Survey do. do. 2 Inches = 1 Mile.
- Surveyed during previous Season (Forest) Scale 4 Inches = 1 Mile.
- Do. do. (Waste land) do.
- T — Tea land (not for Survey).
- Province or State Boundary.
- District do.
- Pargana do.
- Forest do.

NOTES.

The numerals **316**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures in strokes represent the number of the Engraved sheets of the Indian Atlas.

Scale of Miles.

Reg. No. 705, Bengal & S. I. D.—Jan. 93—2,525.

Photo., S. I. O., Calcutta.

229. Although the area is so small it was very scattered, and thus the cost is high, for there was great loss of time in travelling about and tracing out the boundaries of these *jots*, which for the most part lie in high grass and necessitate heavy line clearing, and the boundaries of which were not demarcated. A few *jots* in *pargana* South Mainaguri are situated in the sands of the river Tista, and had no existence as cultivated *jots* when that *pargana* was surveyed in season 1888-89. The small area of detail survey was checked by 22½ linear miles of independent *partal* and by 24½ linear miles of *partal* run on the field sheets by inspectors. Only 5·33 square miles of the cadastral area had to be traversed, as the rest of it lay within the limits of the old traverses.

230. The cadastral section office was located at Jalpaiguri throughout the field season, as its principal work was the completion of the records of the cadastral survey of previous seasons, which had to be furnished to the Settlement Officer. These arrears consisted of 4,919 *jots* and waste land blocks. Some anxiety was felt whether this large amount of work would be accomplished, for the physical condition of the establishment was far from satisfactory, as the men were weakened from constant illness caused by recessing in a feverish place like Jalpaiguri, and there was no possibility of filling up casualties. By great efforts however all the records, inclusive of those of the current season, were sent in to the Settlement Officer by the 20th May, and the party quitted Jalpaiguri by the 25th May 1892.

231. The cost-rate over the whole of the cadastral area of 782 square miles surveyed in the Jalpaiguri district between the years 1888–92, including traverse, survey of fields, mapping and writing of record of rights, is ₹458 per square mile, or annas 11·7 per acre; the average size of the field is 0·68. The most important among the numerous causes which led to this high rate are the excessive unhealthiness of the district and the physical difficulties of working in a country the greater part of which is covered with dense forest. Some of the other causes were the great difficulty in making a comparison between the old and the new boundaries owing to the unsystematic way in which the old records had been kept, the absence of definite names of localities, which caused great delay in hunting up the positions of outlying *jots*, and the unwillingness of the inhabitants to render any assistance to the surveyors.

232. Mr. Hanby complains that allotments of land continued to be made during the progress of the survey, and the demarcation *amins*, paying no attention to what had been surveyed, fixed points wrongly on the common boundaries, and thus caused much unnecessary trouble when the new *jots* came under survey. This was noticed in every *taluk*, but more especially in *taluks* Khuriar Bande and Dhupjhora of *pargana* Chengmari and Gairkhuta of *pargana* Moraghat.

Topographical Surveys.

233. The topographical programme comprised the completion of the survey of the reserved forests of the Western Duars, on the 4-inch scale, and of all arable and non-arable waste lands, on the 2-inch scale, in the area originally allotted to the party, which had not been surveyed on the 16-inch scale, and of which a cadastral survey was not considered desirable. In addition, the relaying of the Bhutan boundary was to be completed, and the survey on the 8-inch scale of two blocks of tea land aggregating 10,000 acres.

The final orders of the Government of Bengal on the proposed season's operations were conveyed in letter No. 470TR, dated 28th September 1891, from the Under-Secretary, Revenue Department. According to these orders the 1-inch scale was to be employed for the waste lands, but this was subsequently cancelled and the adoption of the 2-inch scale sanctioned. Under the authority of the former letter quoted above, also, the classification of growths and soils in the forests was discontinued.

234. Recess work at Hazaribagh closed on the 13th November 1891, and the party re-assembled on the 25th idem at Salsalabari, five miles to the east of Alipore, the head-quarters of the *tahsil* of that name. Considerable delay in commencing field work was caused by the late arrival of the *khalásis* temporarily entertained at Hazaribagh, who on their way to Jalpaiguri halted for a week at Purnea and sent on word demanding a further advance of money

beyond what they had already received on starting. It was not, therefore, till the 5th December that field work actually commenced.

235. There was no triangulation done during the present season, and over the area surveyed topographically, the only traverse work was the remeasuring of portions of two main circuits enclosing the cantonment of Buxa and extending from the northern boundary of the Buxa forest to the boundary of Bhutan, which had been surveyed during the previous season but had not proved mathematically. The area of traverse survey which has been added is 22 square miles. The linear error is extremely large even now; but this is due partly to the mountainous nature of the country in which the work was carried on, and partly to the large correction already applied in the adjoining traverse circuits. The traversing was done with the subtense bar, chain measurements being supplemented wherever practicable.

236. Detail survey was commenced in the eastern half of the district, the party being divided into four sections, each under an European assistant, to which the whole area still remaining unsurveyed between the Torsa and Sankosh rivers was apportioned off: it was arranged that, as each section completed the area allotted to it, the men should be moved across the Torsa river into the western half of the district, where several larger reserved forests still remained for survey. Thus, from the very commencement, the party was scattered over a considerable area of country with large tracts intervening which had either been surveyed in former seasons or were not for survey. This entailed a large amount of marching and consequent loss of time, a serious consideration in such a short field season as is practicable in the Duars. Each assistant had to superintend whatever work fell into his block, whether on the 2-inch, 4-inch or 8-inch scale. Each was provided with an elephant, which not only enabled him to move about more rapidly than is possible on foot, but proved useful in other ways, and as the assistants did not take up any plane-tabling themselves, whenever they were not actually checking a man's work they accompanied one or other of the plane-tablers and kept them up to the mark. The large amount of supervision thus exercised has insured a far greater degree of accuracy than would have been attainable otherwise in a survey of such a jungle-clad country, where the fear of wild animals and the very laborious nature of the work, added to the terrors of a notoriously unhealthy district, rendered the work intensely distasteful to the majority of the men.

237. The area of detail survey on the 4-inch scale of the reserved forests done during the season amounted to 327 square miles.

238. The area of waste land surveyed on the 2-inch scale during the season is 337·17 square miles, the larger part of which lies in *parganas* East Madari, Chakwaheti, Buxa, Bhatibari and Bhalka, with small scattered plots in *parganas* North Mainaguri, Lakhipur, and West Madari. Of this area, the Tista river accounts for 36·41 square miles. The other large rivers in the district whose beds had not been previously surveyed on the 16-inch or other scales are the Jaldhaka, Torsa, Raydak and Sankosh, and, with the exception of the Sankosh, the greater part of all these were surveyed this year either on the 2-inch or 4-inch scales, the latter scale being employed for such portions of rivers as fell into the various forest reserves.

239. A theodolite traverse has only been run along one bank, the inner or Western Duars bank, of both the Tista and Sankosh rivers, and the survey of the Tista river, which was done entirely on the 2-inch scale, was carried out by running a plane-table traverse along the west bank, which was checked by interpolation, various objects whose positions had been fixed from the traverse stations on the east bank being used for intersections. The bed of the Sankosh river has not been surveyed, as the river is not fordable anywhere in the portion adjoining the Western Duars, and it is so wide in places, and there is so much jungle along the east bank, that it would have taken a considerable time to accomplish the survey of it, and it was therefore not considered advisable to take it up.

240. The area of tea lands surveyed on the 8-inch scale amounts to 17·52 square miles, and was carried out for the tea land survey office, Jalpaiguri. The survey of five plots of waste land on the 16-inch scale was originally ordered, but as so long a time had elapsed since the request was made for the survey of these plots, a reference was made to the Deputy Commissioner, Jalpaiguri,

before the commencement of the field season, as to whether the survey was still required, and, if so, whether the 8-inch scale on which the majority of the tea land maps are drawn would suffice. He intimated that the 8-inch scale would suffice, and that the survey of only two plots was required—one of 4,000 acres, called the Jaigaon Tea estate, situated between the North Borajhar and Gabur-basra forest reserves and adjoining Bhutan; and the other 6,000 acres to the south of and adjoining the Dhumpara forest in *taluk* Haldibari Jhar, *pargana* Bhalka. No boundary marks had been erected by the local authorities, and the positions of the boundaries had to be determined so as to include as nearly as possible the areas applied for. This was done in Jaigaon with a theodolite traverse, and large earthen mounds were erected along the boundaries. In the Jaigaon grant the Company had been given preliminary possession; that is to say, had been allowed to enter and commence opening up the grant before the survey had been carried out, the usual procedure being to survey and mark out the land before giving possession.

241. The reason why the survey of these plots was not carried out in season 1889-90 was because the traverse survey of the district had not approached sufficiently close to the localities to enable it to be taken up, and at the commencement of the field season of 1890-91 information was received from the Settlement Officer that these plots would not be given out for tea cultivation; so nothing further was done that season. On the 24th June 1891, the Deputy Commissioner wrote, asking why the survey of Jaigaon had not been done, which led to the survey of these plots being taken up during the present season. In February 1892, information was received from the Deputy Commissioner that he would arrange to carry out the survey of the Jaigaon plot, and that there was no necessity to take up the survey of the other block, as the applicants had not paid the survey fees, and it was thought that they no longer wished to take up the land. By that time, however, the surveys of both blocks on the 8-inch scale had been almost completed, so they were carried through, though no boundaries were determined or marked for the plot in Haldibari Jhar.

242. As the work progressed very slowly at first, and fears were entertained that the district would not be completed this season, orders were issued to the detail surveyors that only the main features were to be accurately surveyed both in the forests and waste lands, and the smaller features sketched in approximately and shown with dotted lines. This however was found impossible, owing to the dense grass and tree jungle which covered almost the entire area under survey this year, and utterly precluded the possibility of any "sketching," so that all the details that have been mapped are as accurate as the scales and nature of the country admit.

243. Many obstacles to the survey were met with. Several fires occurred in the forests this year during the progress of the survey, but enquiries made on the spot in each case at the time of the occurrence proved that the sub-surveyors had no hand in originating them. In the waste lands the grass is burnt annually, though usually not till about February. This season, owing to a scanty rainfall, the inhabitants began burning the grass in December, and though this slightly increased the range of vision and disclosed some of the smaller features which would otherwise have been lost, it did not have much effect on the rate of progress, as it is almost as difficult to force a way through it on foot after it is burnt as before, the thick succulent stems of the giant grass, often as thick as a man's finger, only partially yielding to the destroying element. Along the edges of the water-courses it is generally found that this grass does not get burnt at all, and though its green colour betrays the presence of a stream, it effectually conceals its actual proportions. The country is intersected with innumerable streams, all more or less fringed with this impenetrable grass, most of which have water in them for the best part of the year and soft muddy bottoms, which makes the crossing them most unpleasant at all times, and adds to the dangers and difficulties of survey work in the Western Duars. In the forests where the tree growth is large, this elephant grass is not met with, but a tangled mass of creepers and undergrowth of other sorts supplies its place, and renders a survey with any pretentions to accuracy of detail very laborious and slow.

The tracts that came under survey this year are for the most part uninhabited, and are consequently the haunt of the wild animals that abound in the

Western Duars—elephants, tigers, leopards, bears, buffaloes, bison, and several varieties of deer. These animals, however, were not often encountered by the sub-surveyors and their squads, who kept together as much as possible and took good care to make a considerable amount of noise over their work, and only one casualty occurred: a *khalási* who had got separated from his comrades was attacked by a buffalo and gored to death in the North Borajhar forest.

244. The cost-rate of the 4-inch forest survey, including mapping, is R129·1 per square mile, while that of the 2-inch scale is R67·9. Last season the cost of the 4-inch forest survey was R90·9 per square mile, and the cause of the increased cost this season is that in the forests surveyed this year there were comparatively few fire lines, and the reserves lay at great distances apart, whereas the work of last season lay principally in the Buxa forest in one compact block, and there was therefore little or no time lost in marching, and the forest was well provided with fire lines.

245. In addition to the topographical surveys above reported on, two assistants, Messrs. Hall and Knight, were employed throughout the field season in re-laying the Jalpaiguri-Bhutan boundary in accordance with instructions conveyed in letter No. 488P., dated 4th February 1892, from the Chief Secretary to the Government of Bengal to the Secretary to the Government of India, Foreign Department. Each assistant was instructed to erect intermediate marks between the existing cairns of stones which mark the boundary, and to prepare a careful map of the same on the 4-inch scale, giving enough of the surrounding details on each side of the boundary to enable the positions of the marks to be readily identified. The positions of these intermediate marks have been determined with the plane-table, and not with the theodolite. Such portions of the boundary as mark the limits of forest reserves were surveyed in the ordinary course of the forest survey; numbered wooden posts are erected at short intervals therein, and nothing was required to be done in such portions.

The survey on the 4-inch scale has been done of 75·93 linear miles of the boundary, comprising an area of 25 square miles.

A special report on the boundary survey has been submitted to the Government of Bengal, and a copy thereof, with a vellum trace of the map, was sent to the Deputy Commissioner of Jalpaiguri for information.

246. A good deal of sickness was experienced during both the field and recess seasons, though the close supervision that was exercised by the assistants probably accounted for there being a good deal less sickness than during the previous seasons; but the present was undoubtedly a less unhealthy one than usual, owing to the comparatively slight rainfall of 1891. At the commencement of April the rains set in, when 180 square miles, chiefly of forests, still remained to be surveyed: sickness among the sub-surveyors did not increase, though the wretchedly clad *khalásis* suffered considerably, and the survey was almost accomplished by the end of the month. There were 21 deaths among the *khalásis*—under 4 per cent.—of which eight occurred on the road from Hazaribagh to Jalpaiguri. There were also 28 desertions among the *khalásis*, and two sub-surveyors absconded.

247. The field work of the topographical section closed on the 5th May, and recess office was opened on the 17th idem at Hazaribagh, when the final examination of the 16-inch cadastral sheets was resumed; and also the preparation of standard maps on the 2-inch scale for reduction to one-half, and special forest maps on the 4-inch scale for reproduction to scale.

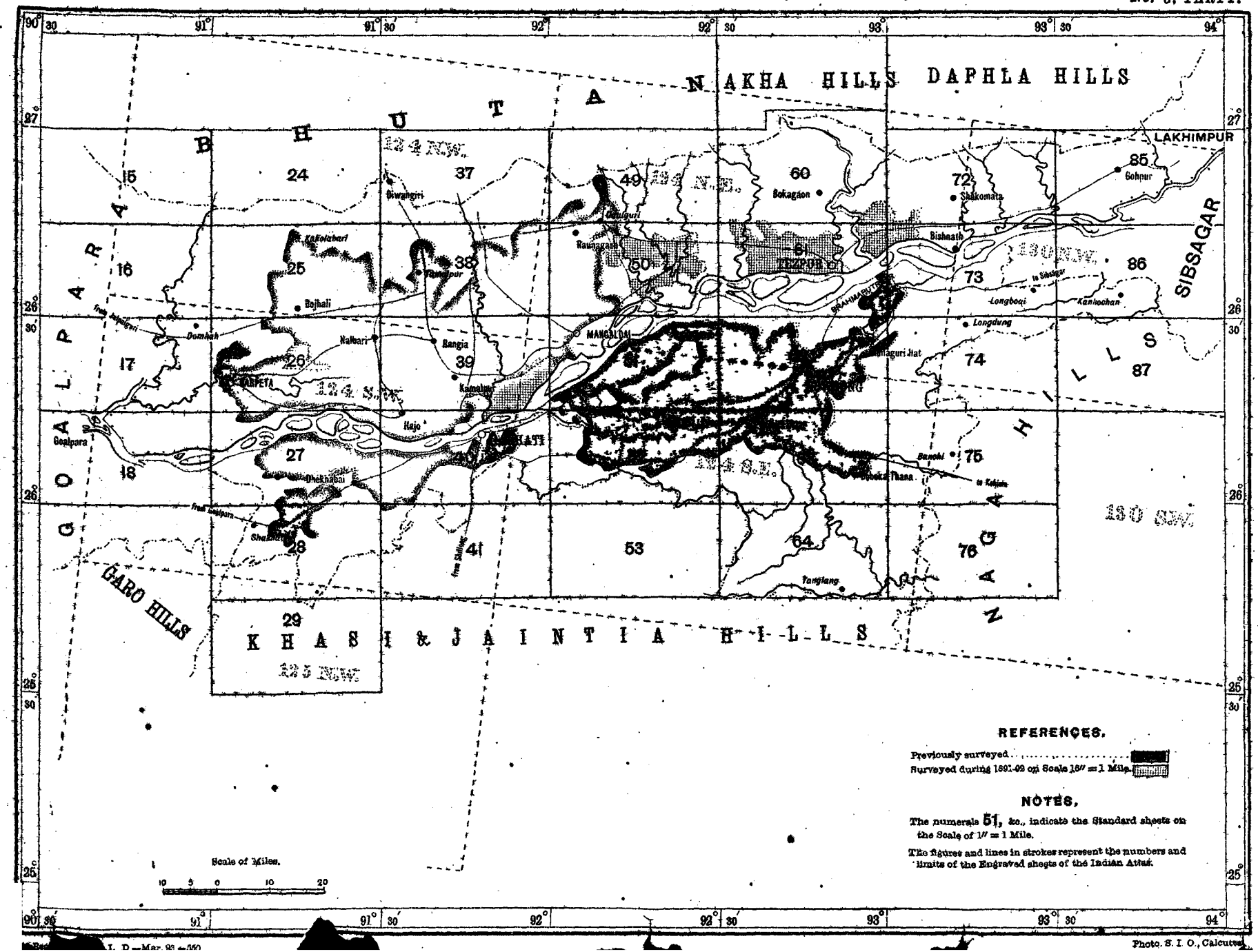
248. The season's work has been mapped on 159 sheets, of which 17 are on the 8-inch scale, being special work for the Jalpaiguri tea land survey, 91 sheets are on the 4-inch scale (78 forest, 12 Bhutan boundary, and 1 waste land commenced last season), and 51 sheets, consisting of waste lands, on the 2-inch scale.

The 2-inch mapping of the district is comprised in 36 standard quarter sheets, all of which have been projected and plotted and margins drawn, but are all in an incomplete state. Five sheets have been outlined in ink, with the exception of the portions known as tea lands, which do not fall into the present survey, of which details are to be entered from maps received from the Jalpaiguri tea land survey. In two of these five sheets the tea land covers very small portions of the sheets. Nine sheets are completed in outline in pencil, with the exception of the tea lands which fall into and cover a considerable

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. KAMRUP, DARRANG, & NOWGONG.

No. 6. PARTY.



I. D.—Mar. 93—550

Photo. S. I. O., Calcutta.

area of three of them. Six sheets are only partly pentagraphed, but four of these are partly inked in as well. One sheet is plotted only.

The 4-inch mapping of the forests was taken up first: of these, there are 48 standard sheets. All have been outlined in ink, and borders and headings completed. The examination of all but four has been completed, as far as can be done in the present state of the maps.

249. When the forest survey was commenced in season 1890-91, instructions were received from the Forest Department that all streams which formed the boundaries of reserves were to be included in the reserves. As however such streams had already been included by the cadastral surveyor in the areas of the adjoining *jots*, a revision of a large number of the area books and of the offset entries in the traverse volumes has been necessitated. It has not been found possible as yet to take up this revision; but it will be effected by the field office during the ensuing cold weather, a note being made in the area books that a certain area has been transferred to the adjoining forest, and in the traverse volumes the offset entries will be altered.

250. It had been decided that the details of the tea lands which had been surveyed under the Revenue authorities should be incorporated in the 1-inch standard sheets. A large number of the sheets which are on the 8-inch scale have been reduced by pentagraph, but a comparison of these with the work by this party shows such discrepancies that the work was stopped; whether any use can be made of these maps of the tea lands has yet to be decided. Plotted copies of the 8-inch sheets—three in number—of the Jaigaon tea estate were prepared for the Deputy Commissioner and despatched in September.

251. The final examination of the 16-inch cadastral sheets was carried on during the recess, but was not quite completed; the remaining sheets, 121 in number, will be completed shortly.

252. Having completed the survey of the Western Duars, the party has been transferred to commence the cadastral survey of Northern Bihar.*

ASSAM.

No. 6 Party.

253. This party, of the strength indicated in the margin, left recess quarters at Shillong on the 25th October 1891 for Tezpur, where the field offices were established. Field operations were continued in the districts of Kamrup, Darrang, Sibsagar and Lakhimpur, of the Assam valley, and in the district of Sylhet. The party continued in the field till the 10th June 1892, when it returned to recess quarters. Mr. Barrett continued in charge throughout the year, with the exception of 3 months during the recess season, when he obtained privilege leave, and Mr. O'Donel, the senior Extra Assistant Superintendent, acted for him.

Personnel.

Mr. E. C. Barrett, Superintendent, 2nd grade, in charge up to 27th June 1892.
„ J. H. O'Donel, Extra Assistant Superintendent, 3rd grade, in charge from 27th June 1892.
„ C. W. Wilson, Extra Assistant Superintendent, 4th grade.
„ J. Smith, Sub-Assistant Superintendent, 2nd grade.
23 sub surveyors and others.

Temporary Establishment.

81 inspectors, draftsmen, computers, etc.
34 field surveyors (imported).
112 *mandals* and candidates (local).

254. Mr. Smith, Sub-Assistant Superintendent, assisted by 6 sub-surveyors and inspectors, on the 1st October opened a survey class at Tezpur for the instruction of the *mandals* (village headmen) intended for employment in the survey of the fields. One hundred and six *mandals* went through the course, of whom 99 qualified as field surveyors, 80 being retained for actual work. Besides the *mandals*, 40 local men were trained in the survey class. In addition to the local men trained under the direct supervision of Mr. Smith, Messrs. Medlicott, Duncan, French, Nicholls, and Reid, of the Civil Service, 3 Sub-Deputy Collectors, 2 *tahsildars*, 1 *kanungo*, 11 *tahsil moharrirs*, 2 Government surveyors, 6 *mandals*, 2 school-masters, 4 clerks, 4 *mauzadars*, and 73 local men were placed with

* Captain Hodgson commends the effortsof Messrs. Hanby, Hall, Berkeley, Smart and Wood; also Irfanali, Peari Lal, Ramjas Misir, Wazarat Husein, Nila-dhar, Patandin, Hyat Mohamed I, Hyat Mohamed II, Mahadeo Ram Azimulla, Mahabir Pershad and Dalmir Khan.

amins, and received practical instruction in field surveying, making, with the 146 *mandals* and candidates referred to above, a total of 5 officers and 254 local men, which is considerably in excess of the number trained in any pevious year.

255. Cadastral survey in the Assam valley was carried on as heretofore by imported and local agencies, 29 Hindustani *amins* and 102 local men being employed during the year. The Hindustanis, who were as a rule employed on the more difficult descriptions of survey, were each attended by a deputy *mandal*, whose duty was to write up in Bengali the village record locally known as the *dag chitta*. In Sylhet, 13 Bengali *amins* were employed in the field-to-field survey and 2 Hindustani *amins* and 2 sub-surveyors in the survey of grants. The *mandals*, who are salaried Government servants, received pay for their survey work at one-third the contract rates allowed to Hindustani *amins*, while all other local men received remuneration at two-thirds of those rates. The average area surveyed daily by each of the different agencies employed was—

In the Assam Valley.

By Hindustani *amins*	23·49
„ *mandals* (new)	10·24
„ candidates (old)	22·60
„ candidates (new)	12·41

In Sylhet.

By Bengali *amins*	11·57
„ local *amins*	10·41
„ Hindustani *amins* and sub-surveyors	41·19

256. The boundaries of a few of the grants were found marked by prisms and masonry pillars, but as a rule there had been no previous attempt at demarcation of any kind. In the Assam valley, where new villages were formed by the survey, stone prisms measuring 3′ × 1′ × 1′ (when available) were placed at village tri-junctions, but owing to the local administration not having been able to procure prisms from Calcutta in time, the marking of about 38 per cent. of the tri-junction points had to be left to be done by the Settlement Department. In the Jaintia *parganas* of Sylhet all village tri-junctions had been marked by blocks of stone when the last survey was effected, but it was found that quite 45 per cent. of these stones had disappeared; all the lost marks have been replaced by stone prisms of similar dimensions to those used in the Assam valley. Branches of *simal* (silk-cotton) and other quick-growing trees have been planted at an uniform distance of 5 feet to the magnetic north of all theodolite stations in the Assam valley and Sylhet: mounds of earth, 4 feet high and 6 feet in diameter, have been thrown up around the boughs, but the experience of the past two years has shown that these should be protected by bamboo fencing, otherwise the mounds are liable to be destroyed by cattle or washed away during the rains. It has now been arranged that in future all traverse stations shall be protected by mounds heaped up around several boughs and encased in bamboo fencing, the whole to be of a certain fixed size. These are to be erected in the first instance by the traverse surveyors and the cadastral *amin*, who during the field-to-field survey will report whether the orders have been carried out, and, if not, will call attention to the deficient marks, or shall, if possible, have them repaired before he leaves the village.

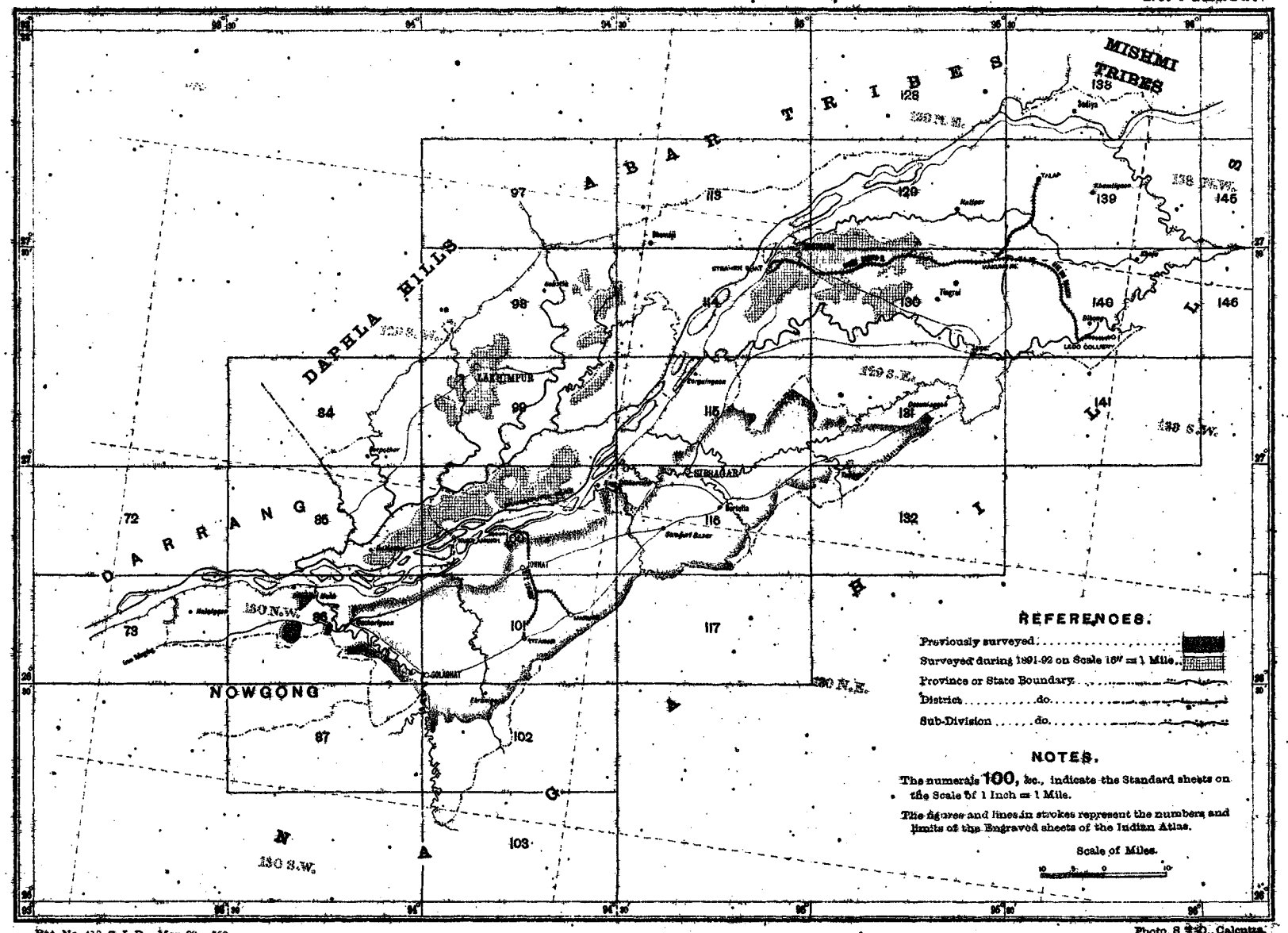
257. The season's out-turn of traverse and cadastral survey is given in the following statement:—

Districts.	Traverse Survey.			Cadastral Survey, 16 inches = 1 mile.		
	Number of *mauzas*.	Number of villages.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Kamrup	...	...	...	31	7,757	26·92
Darrang	4	78	81·18	326	83,440	310·08
Sibsagar	2	140	149·88	140	25,123	150·21
Lakhimpur	23	318	269·24	319	96,704	269·25
Sylhet	17	418	347 00	77	14,816	71·69
Total	46	954	847·30	893	227,840	828·15

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICTS SIBSAGAR & LAKHIMPUR.

No. 6 PARTY.



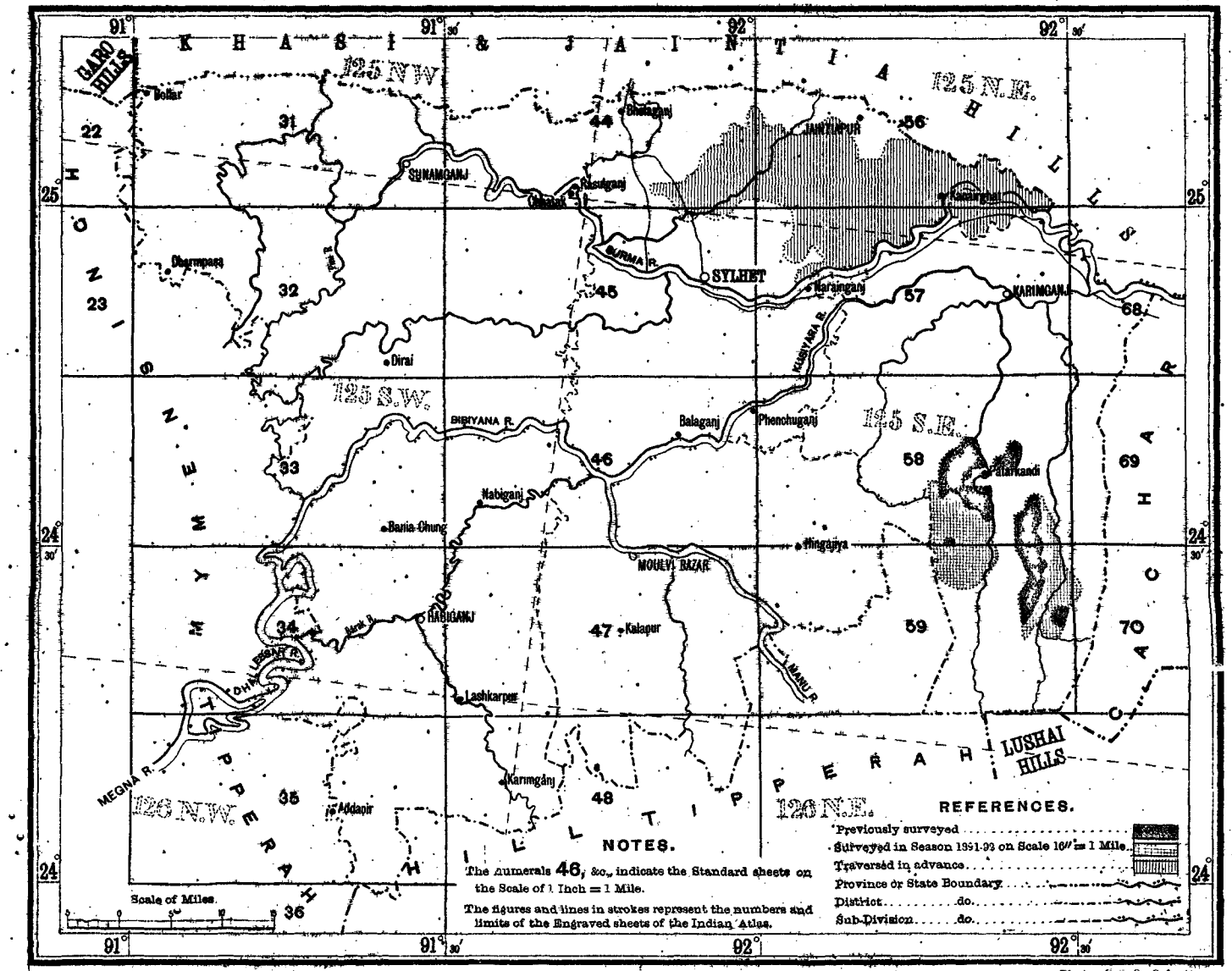
Reg. No. 419, S. I. D.—Mar. 93—550.

Photo. S. I. O., Calcutta.

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT SYLHET.

No. 6 PARTY.



Reg. No. 359, S. I. D.—Mar. 93.—350.

Photo., S. I. C., Calcutta.

258. In addition to the area completed on the scale of 16 inches = 1 mile, 9 islands in the Brahmaputra and the portions lying between the area cadastrally surveyed last year in district Kamrup and the river banks, measuring 23·5 square miles, have been surveyed topographically on the scale of 2 inches = 1 mile.

259. At the request of the Chief Commissioner, the town and cantonments of Dibrugarh have been surveyed on the scale of 32 inches = 1 mile.

260. The area surveyed contains the following grants and other estates :—

Districts.	Grants, Fee simple.		Grants, 30-year lease.		*Lakhiraj* (rent-free).		*Nisf-khiraj* (half rent).		*Ilam* (temporarily settled).	
	No.	Area in acres.	No.	Area in acres.	No.	Area in acres.	No.	Area in acres.	No.	Area in acres.
Kamrup	...	...	...	...	...	...	37	884·84	...	...
Darrang	7	2,276·72	1	271·56	6	164·31	61	21,94·97	...	...
Sibsagar	1	516·15	...	...	24	27,497·56	2	23·47	...	...
Lakhimpur	25	16,697·85	12	3,635·90	11	186·79	47	1,070·59	...	...
Sylhet	...	...	29	17,689·89	...	...	...	...	1	1,327·23
TOTAL.	33	19,490·70	42	21,597·35	41	27,848·66	147	4,173·87	1	1,327·23

261. Heavy rains set in over the Assam valley and Sylhet towards the close of March 1892, and almost paralyzed field operations. During the week ending the 2nd of April, no less than 61·54 inches of rain fell in the hills immediately adjoining the Jaintia *parganas*, the result of which was that the country was flooded and the work completely stopped. The rain continued almost without intermission till about the 15th of May, when a break occurred which enabled the men to resume field work. The rainfall in the hills for the seven weeks ending the 14th of May was 166 inches against a fall of 25 inches recorded during the same period last year. In the plains of Sylhet and in the Assam valley, the rainfall during April and May was almost twice as heavy as last year.

262. The cadastral survey in the Assam valley has been tested by 2,078 linear miles of check survey, which gives an average of $2\frac{3}{4}$ linear miles to the square mile surveyed. In Sylhet, 60·78 linear miles of check survey was run, which is equal to 1 linear mile of check to the square mile of survey. Village sites were tested by the re-survey of a portion of each site. The entries in the village records of 48,539 fields were examined on the ground by European and native officers. Two Sub-Deputy Collectors and 1,141 *munsarims* of the Settlement Department were also occupied throughout the field season in testing the accuracy of the entries in the records. The rectangular co-ordinates of 14 Great Trigonometrical Survey stations have been used for the correction of the traverse distances, and the angular work has been checked by observations for azimuth taken at 115 stations.

263. The average cost of the cadastral survey, including traverse, detail survey, mapping, completion of records and statistics, amounts to R108·6 per square mile in the Assam valley and R97·8 per square mile in Sylhet.

264. The season's out-turn has been mapped on 1,001 sheets. Tracings of the maps and the village records of the area completed in the Assam valley have been forwarded to the Settlement Officer. The tracings and records of the area surveyed in *pargana* Pratabgarh (Sylhet) have been sent to the *tahsildar* of Patharkandi.

265. The revision of the work of season 1890-91 was undertaken by 7 field surveyors, each of whom was attended by a Settlement *munsarim*. The number of objections raised by the *rayats* was 3,961 against 5,434 in 1890-91 and 10,409 in 1889-90.

266. The field season was, on the whole, fairly healthy; fever and bowel complaints were prevalent during April and May after the rains had set in. Mr. Wilson was obliged to take sick leave from the 22nd April till the close of the field season owing to an attack of fever. An *amin* and a cadastral office hand died of fever and dysentery in May, and a sub-surveyor died of dysentery in September.

267. Mr. Barrett expresses his indebtedness to the Deputy Commissioners of the five districts in which survey operations were carried on, and also to the Sub-Divisional Officers of Karimganj and North Lakhimpur, for the effectual manner in which they furthered survey operations. The relations between the Survey and Settlement were most cordial throughout the year.

268. The Deputy Surveyor-General visited Shillong in September 1892, when he inspected the office of the party, examining the cadastral sheets, traverse computations and all other office records, all of which were found to be satisfactory. For the sake of economy the European supervision of the party has been reduced to a minimum, if not somewhat below what is necessary for an efficient check on the work. To counteract this as much as possible, orders were given to run a greater number of *partal* lines between points given to the inspectors, the results of which being recorded in a field-book can be plotted and compared by the Superintendent in office; the completed sheet is kept under lock and key in the office, which prevents any possible collusion between the inspector and the *amin*. This forms as good a check as a *partal* run by a European assistant. The Deputy Surveyor-General also interviewed the Director of Land Records and the Chief Commissioner, when the programme for 1892-93 was discussed and arranged, and certain minor points connected with the junction lines of sheets, the erection and inspection of traverse stations and the more rapid supply of area statements, were discussed and arranged for the future.*

AMHERST, TAVOY AND MERGUI DISTRICTS, LOWER BURMA.

No. 7 Party.

269. This party was employed during the season in the Amherst, Tavoy and Mergui districts, work having been carried into the two last-named localities in accordance with the decision arrived at in the conference held at Rangoon on 25th April 1891, as mentioned in paragraph 289 of the Annual Report for 1890-91. The area of the operations was thus very extensive, and necessitated the sub-division of the party into two sections, one of which, under Mr. Wood's immediate superintendence, continued the work in Amherst, whilst the other, under Mr. Littlewood, commenced the survey of the cultivated portions of Tavoy and Mergui.

Personnel.

Mr. C. Wood, Officiating Deputy Superintendent, 2nd grade, in charge.
„ H. R. Littlewood, Officiating Assistant Superintendent, 1st grade, from 25th November 1891.
„ R. B. Smart, Extra Assistant Superintendent, 3rd grade, from 1st November 1891.
„ G. W. Jarbo, Extra Assistant Superintendent, 4th grade.
„ J. Murphy, Sub-Assistant Superintendent, 1st grade, from 14th November 1891.
„ M. Gastaud, Sub-Assistant Superintendent, 1st grade, from 30th October 1891.
„ F. B. Powell, Sub-Assistant Superintendent, 2nd grade.
„ W. H. Biggie, Sub-Assistant Superintendent, 3rd grade, from 31st December 1891.
22 surveyors and others.

Temporary Establishment.

69 inspectors, draftsmen, computers, etc.
110 field surveyors.

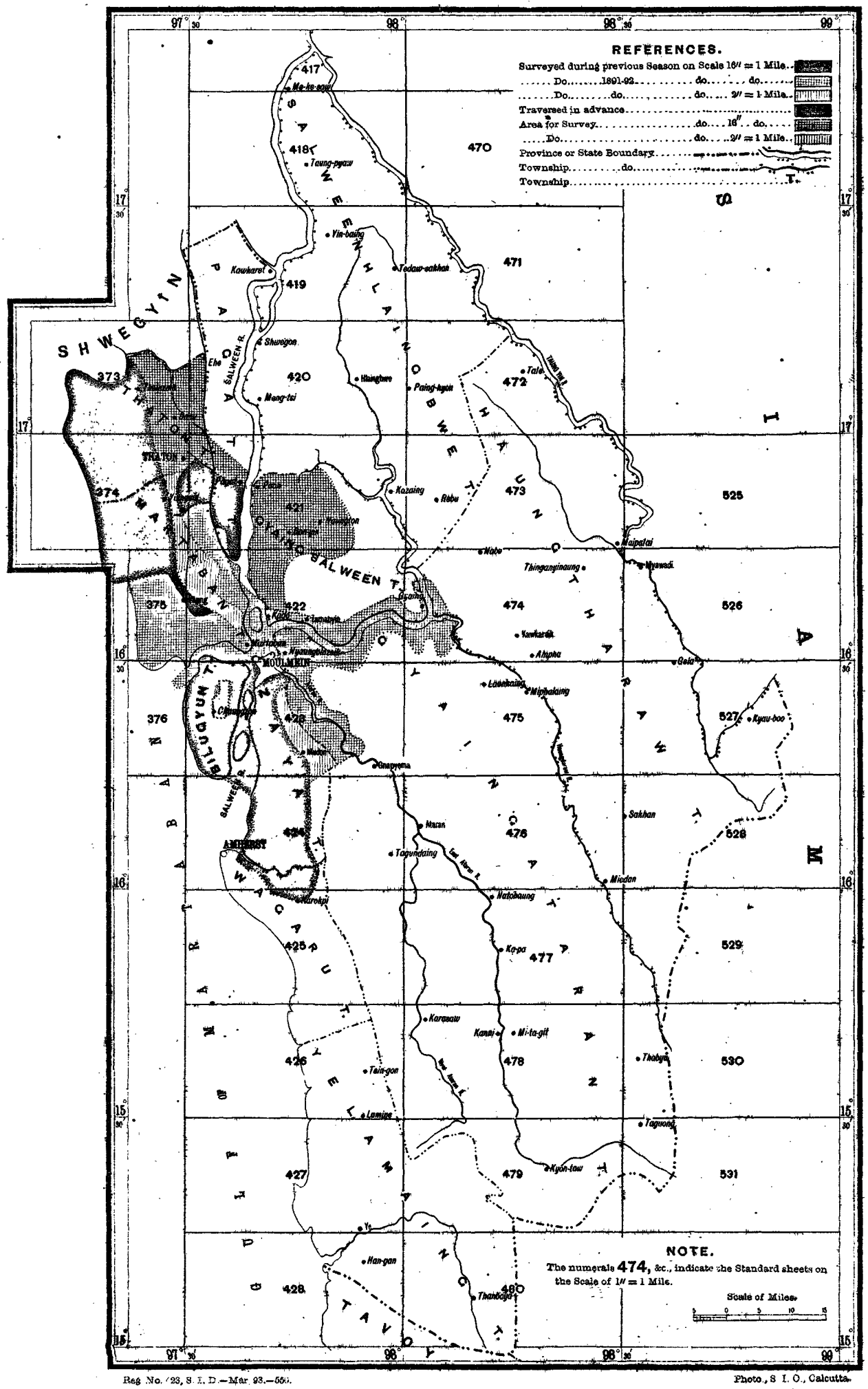
270. As no advance boundary survey had been executed in these last-named districts, it was necessary for the traverse surveyors to commence work as early in the season as practicable. Accordingly, two surveyors were sent on to Tavoy on the 10th October 1892, and the main body of the traverse squads left Rangoon on the 22nd idem by the Government

*Mr. Barrett again writes, in the highest possible terms, of his senior assistant, Mr. J. H. O'Donel. Messrs. Wilson and Smith are reported to have done good work during the recess. The under-noted members of the native establishment are considered deserving of special mention: Sakhawat Hossein, Khurshed Hossein, Khairuddin, Janardan Rao, and Chatterpul Singh, sub-surveyors; Gholam Hyder Khan, draftsman; Krishnaji Mahadeo Raj, computer; and Babu Sitanath Chuckerbutty and Jhuni Lal, of the cadastral establishment.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT AMHERST.

No. 7 PARTY.



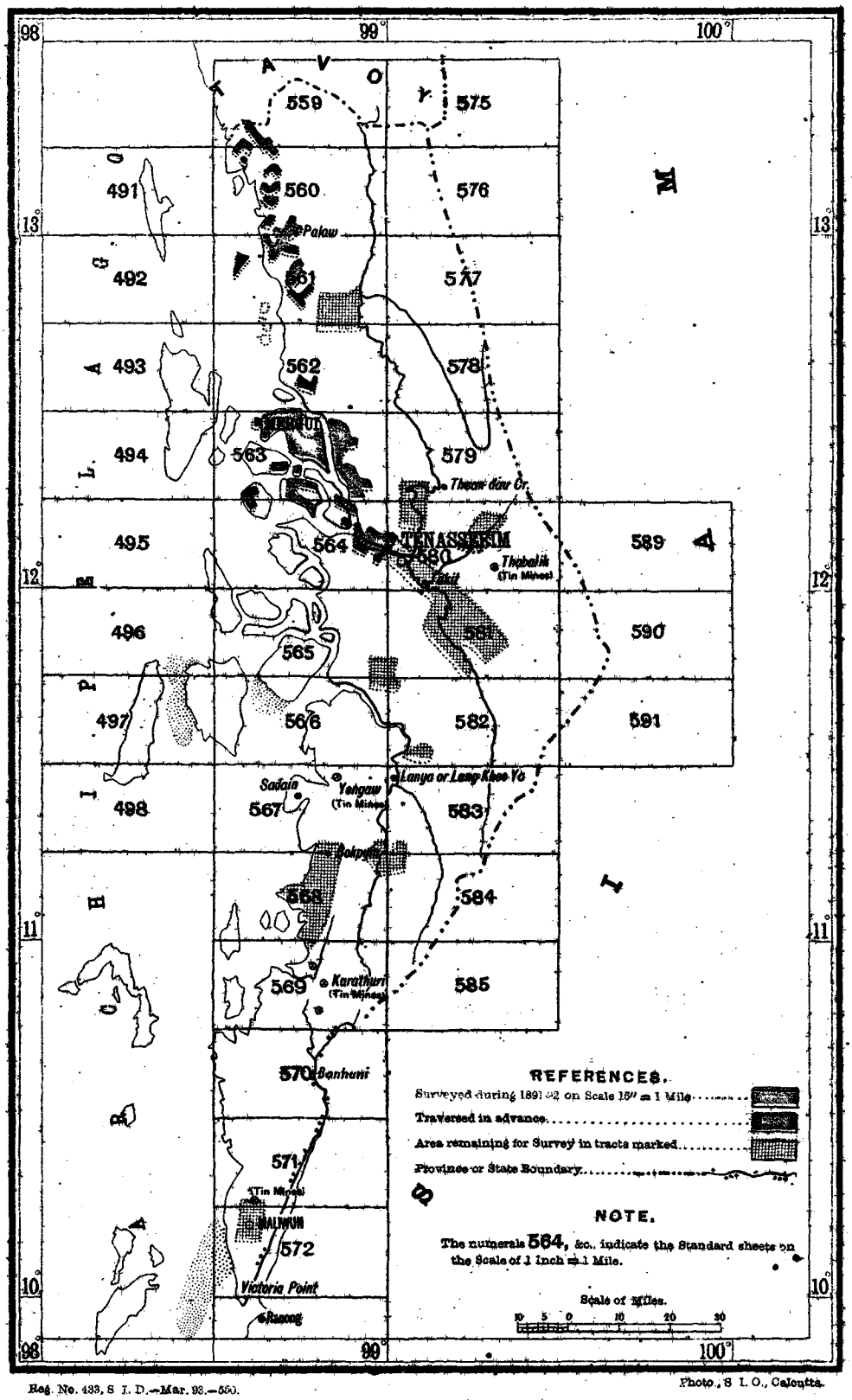
Reg. No. 723, S. I. D.—Mar. 93.—550.

Photo., S. I. O., Calcutta.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT MERGUI.

No. 7 PARTY.



Reg. No. 433, S. I. D.—Mar. 93.—550.

Photo., S. I. O., Calcutta.

steamer "Mayo": the traverse section for Amherst took the field in the last week of October. The greater part of the cadastral section left Rangoon for Amherst on the 3rd December; a small squad under Mr. Littlewood was, however, sent forward on the 30th November to Tavoy. The remainder of the cadastral establishment for Tavoy and Mergui joined a month later, having been kept at work at Moulmein until the boundary survey had made sufficient progress. Owing to the early setting in of the rains, the Amherst sections returned to recess quarters on the 24th May; the Tavoy and Mergui sections, however, kept out till the end of the month, and arrived in Rangoon on the 6th June by the Government steamer "Dalhousie."

271. The work of the season comprised the following operations:—

In Amherst, (i) the traverse survey of 423 square miles in the Martaban, Thaton and Pagat townships; (ii) the cadastral survey on the 16-inch scale of 550 square miles in the Gyaing-Ataran, Gyaing-Salween, Haung-tha-raw, Bilugyun and Martaban townships; and (iii) the topographical survey, on the 2-inch scale, of 106 square miles in the Zaya, Bilugyun and Martaban hills.

In Tavoy, the traverse or boundary survey of 408 square miles and the cadastral survey of 310 square miles in the four townships of the district, on the 16-inch scale.

In Mergui, the boundary survey of 187 square miles in the Mergui, Palaw and Tenasserim townships, of which area 150 square miles were cadastrally surveyed, on the 16-inch scale, in the two first-named townships.

272. It was at first thought possible that the survey of the cultivated tracts in Tavoy and Mergui could be finished in one season to admit of revised assessments coming into force in 1892-93; but the extent of ground to be brought under survey was found to be much larger than was expected; and notwithstanding every endeavour to push the work on, a considerable area (about 130 square miles in Tavoy and about 100 in Mergui) still remains for completion in 1892-93.

273. Settlement operations were also carried on during the season by a *myook* and his staff of holding-markers, etc., working under the direction of this party. In order to admit of this work proceeding as nearly as possible *pari passu* with the detail survey, tracings were supplied almost immediately after the sheets received from the field surveyors had been examined, and no time whatever was lost in revising the same after the holding-markers had gone over the ground. The demarcation in gardens having originally been very defective, a good deal of revision work had to be done in consequence. Nevertheless, complete settlement registers were prepared for 167 *kwins* in Tavoy and 56 in Mergui (leaving only the classification of gardens to be taken up hereafter by the Settlement Officer of the Tenasserim division); and the demarcation of holdings was further completed in 14 *kwins* of the former and 73 of the latter district. The *kwin* demarcation in the Amherst district was all that could be desired, but not so in Tavoy and Mergui, where in many instances it was confined to the fixing of stakes at intervals along the edge of cultivation—an undertaking obviously superfluous, as those limits are visible on the ground without any demarcation. Possibly this may be due to the circumstance that whereas in Thongwa, Amherst, and other parts of Lower Burma a *kwin* is understood as the local equivalent of the Indian *mauza* (village), in Tavoy and Mergui it is evidently taken as the equivalent of *purwa* (hamlet), and so is practically applied to each detached patch of cultivation.

274. All the traverse stations were marked in the usual way and measures taken, as detailed in paragraph 283 of the Report for 1889-90, for their protection. No difficulty worth mentioning was experienced in getting the *ywathugyis* (revenue officials of *kwins*) to take over the custody of the station marks. The angular results of the season's traverse survey have been checked by star observations for azimuth at 235 stations, and the linear results were checked by connection with 20 stations of the trigonometrical and 2 of the topographical surveys: in both cases, the smallness of the corrections required (*viz.*, 4 seconds per angle and $6\frac{1}{2}$ feet per mile) shows that the work was satisfactorily done. The detail survey on the 2-inch scale was tested by *in situ* fixings and by connection with the traverse stations; while that on the 16-inch scale was checked by 1,948 miles of chain measurements, of which 340 miles were run by Europeans.

275. The following statement shows the out-turn of the season's work, both as regards traverse and detail survey :—

District.	Traverse Survey.		Cadastral Survey, 16 inches=1 mile.				Topographical Survey, 2 inches=1 mil.
					Area in square miles.		Area in square miles.
	No. of *kwins.*	Area in square miles.	No. of *kwins.*	No. of fields.	Cultivation.	Jungle and waste, including water.	
Amherst . .	241	423	382	480,000	284	266	106
Tavoy . .	388	408	342	350,000	185	125	...
Mergui . .	214	187	157		50	100	...
Total .	843	1,108	881	830,000	519	491	106

276. It will be seen that the cultivation practically comprises one-half the total area surveyed, both in the Amherst and in the Tavoy-*cum*-Mergui districts. The average size of the fields this year, reckoned on cultivation only, in Amherst is 0·38 of an acre, while in Tavoy and Mergui taken together it is 0·54 of an acre. Reckoning that the expenditure in surveying 4 square miles of jungle is equal to that of 1 square mile of cultivation, the cost per square mile of cultivation for Amherst is R186¼ and for Tavoy and Mergui R216¾: the similarly worked out figure for the year 1890-91 (average size of field = 0·64) is R198¼. So that, notwithstanding the very many difficulties and increased expenses incident to work in Tavoy and Mergui, the detail survey in these districts has only cost about 6 pies per acre more than under nearly the same conditions as to size of field in 1890-91; while the work in Amherst has cost about 3½ pies per acre less than before, notwithstanding the small average size of the field dealt with this year.

277. The season's cadastral survey on the 16-inch scale is mapped on 1,623 sheets, and the 2-inch mapping enters into 3 of the standard 1-inch sheets. Of the sheets of the previous seasons, the whole of those appertaining to Thongwa (*i.e.*, 943 sheets) have, during the year under report, been sent to Calcutta for printing, while the 550 sheets appertaining to Amherst have been retained till next spring, pending the completion of the settlement operations now in progress in that district. The fair drawing on the 2-inch scale of the Thongwa survey, for reduction to half scale, has been all but completed, and the sheets are in course of publication at Calcutta: the little drawing that still remains to be done will be completed as soon as prints of the 16-inch work are available; and in the meantime the 2-inch scale drawing of the Amherst survey is being pushed on.

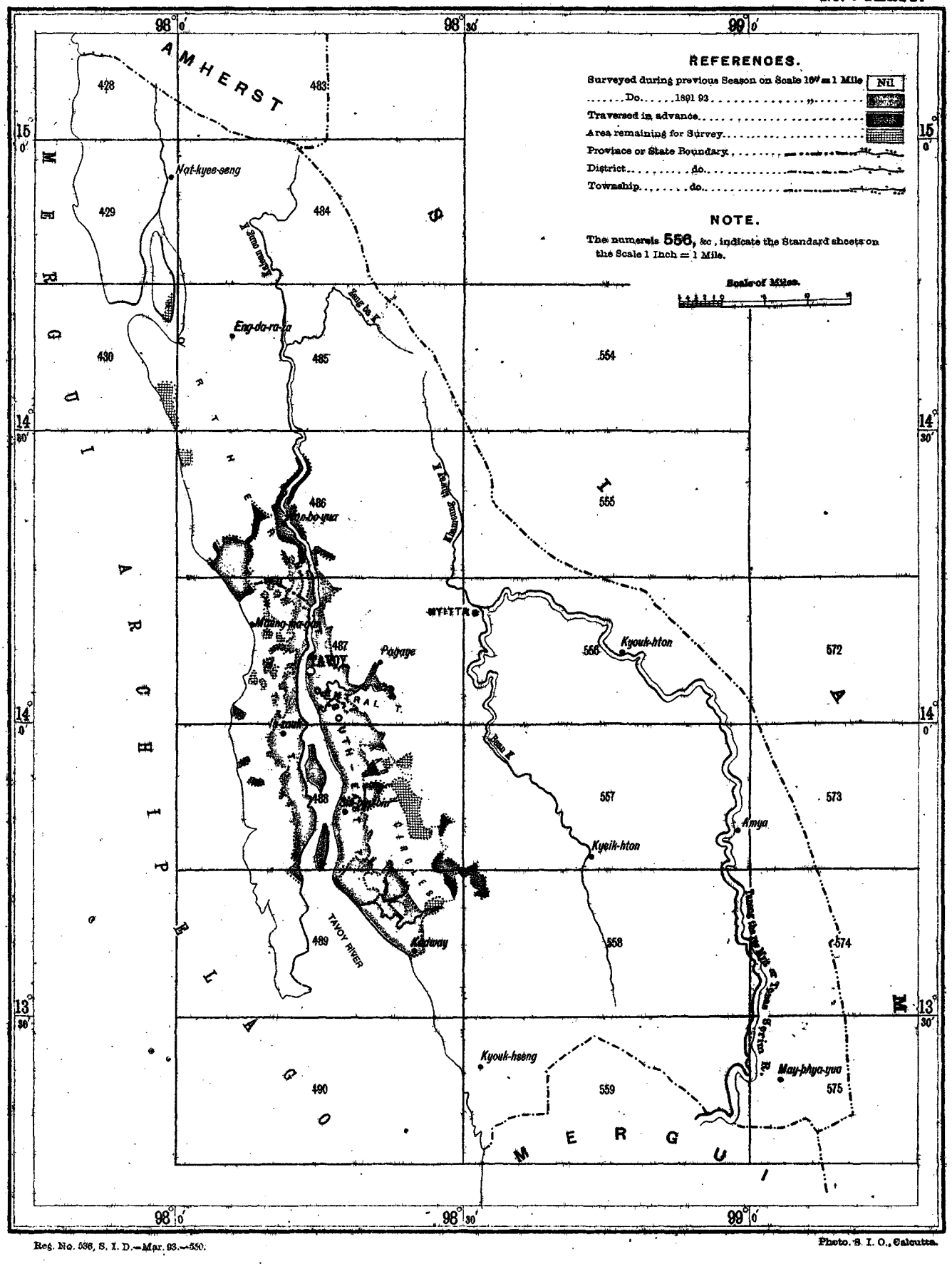
278. The records of the present season's work have been indexed and bound. The field books and traverse computations of the entire Thongwa survey have been lodged in the Calcutta office, and the volumes of area statements will shortly be forwarded.

279. The scheme for the employment of Burmans and Karens as field surveyors has worked satisfactorily during the year. Of the 20 men who qualified for a certificate and deferred pay in 1890-91, only nine returned to this party last November; 24 others have this year similarly qualified and been given their certificates and deferred pay. The average monthly earnings of this field season are R35-11 against R39-11 of the year before: this is due entirely to the more intricate character of the work and the slower rate of progress in consequence; but as the field season was somewhat longer than usual, the total earnings have exceeded those of any previous year. The average out-turn of the Burman has this year again been found to be four-sevenths of that of the Hindustani; and though they are both paid at the same rates for the actual out-turn of work, yet

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT TAVOY.

No. 7 PARTY.



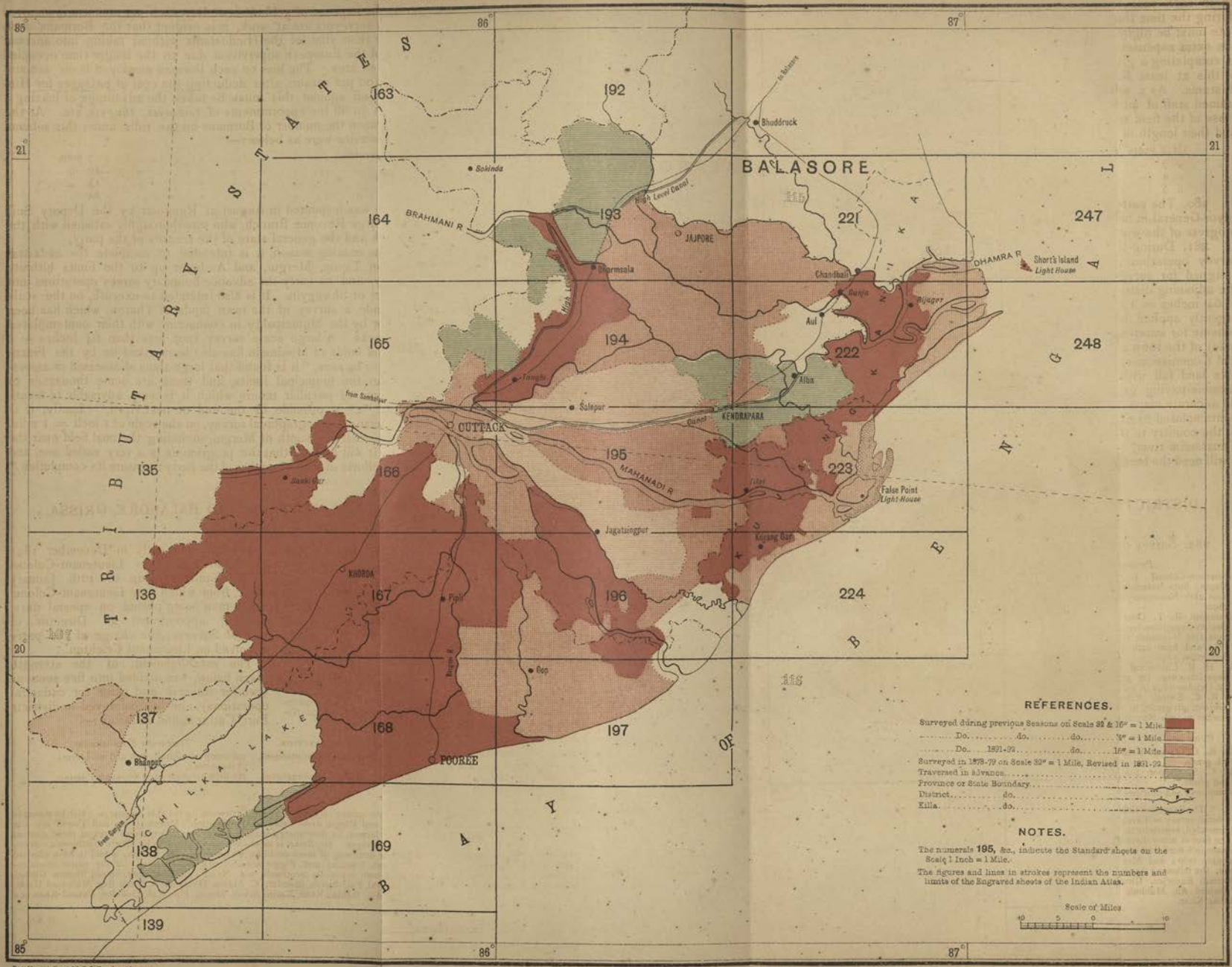
Reg. No. 536, S. I. D.—Mar. 93.—550.

Photo. S. I. O., Calcutta.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF ORISSA, DISTRICTS CUTTACK & POOREE.

No. 8 PARTY.



REFERENCES.

Surveyed during previous Seasons on Scale 32" & 16" = 1 Mile
Do. do. do. 8" = 1 Mile
Do. 1891-92 do. 16" = 1 Mile
Surveyed in 1878-79 on Scale 32" = 1 Mile, Revised in 1891-92
Traversed in Advance
Province or State Boundary
District do.
Killa do.

NOTES.

The numerals **195**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

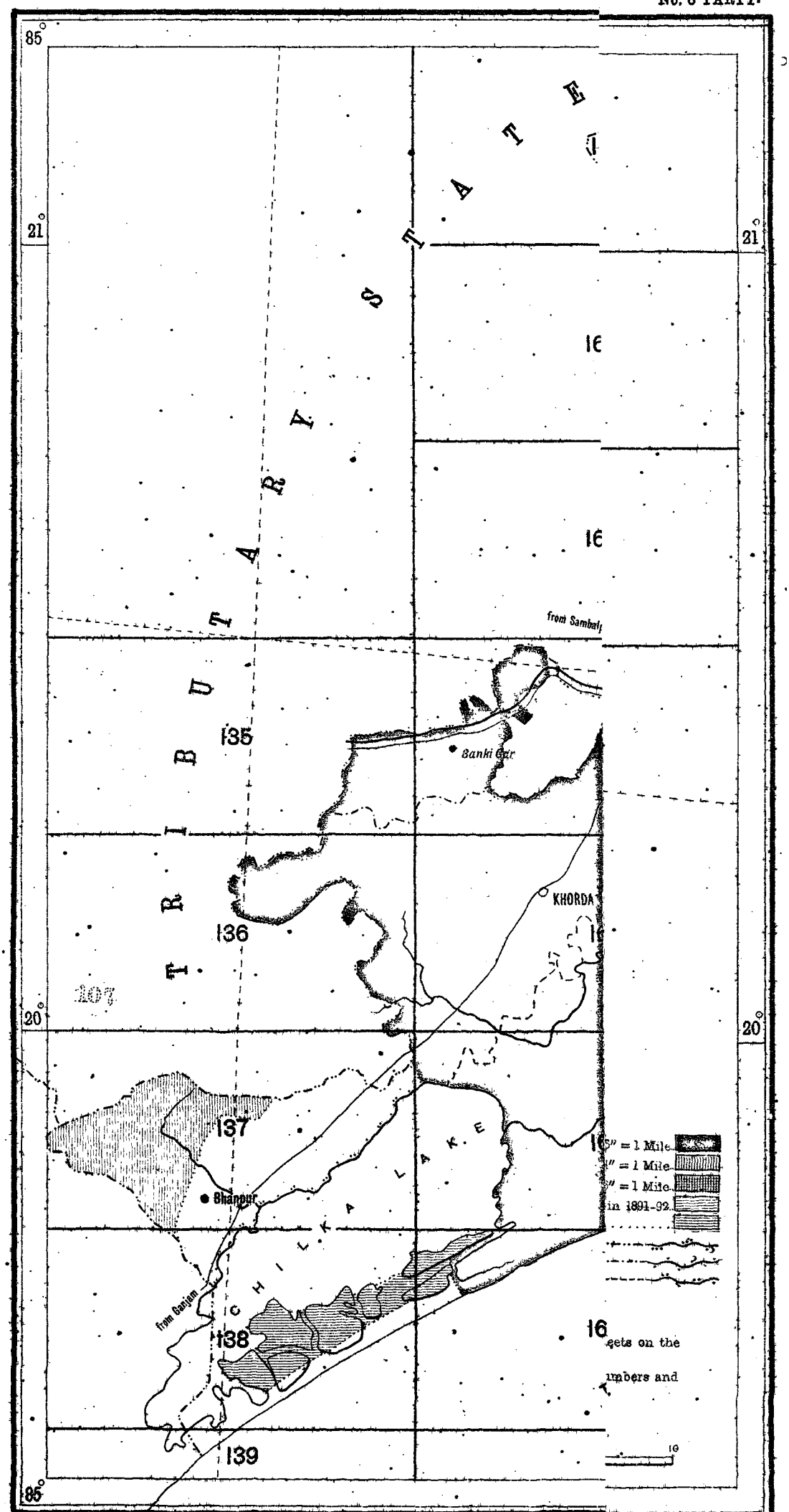
Scale of Miles
40 5 0 10

Reg. No. 401. Bengal & S. I. D. — Jan. 93.—2,000.

Photo., S. I. O., Calcutta.

INDE

No. 8 PARTY.



Reg. No. 484, Bengal & S. I. D. – Jan. 93.–2,252.

Photo., S. I. O., Calcutta.

as in each case the expense of 4 *khalâsis* at R10 each per mensem is incurred during the time the surveyors are at work, it is evident that the Burmans' cost-rate must be higher than that of the Hindustanis without taking into account the extra expense of the European supervision due to the longer time occupied in completing a given area. The loss on each Burman employed is on account of this at least R100 per season, after deducting the cost of passages for Hindustanis. As a set-off against this must be taken the advantage of leaving a trained staff of men to fill the appointments of *teiksayes*, *thugyis*, etc. At the close of the field season the number of Burmans on the rolls under this scheme and their length of service were as below:—

Of 2 years' service	.	.	.	.	.	.	.	7 men.
„ 3 „ „	.	.	.	.	.	.	.	10 „
„ 4 „ „	.	.	.	.	.	.	.	13 „
„ 5 „ „	.	.	.	.	.	.	.	24 „

280. The party was inspected in August at Rangoon by the Deputy Surveyor-General in charge Revenue Branch, who was thoroughly satisfied with the progress of the work and the general state of the records of the party.

281. During the ensuing season, it is intended to complete the cadastral survey operations in Tavoy, Mergui, and Amherst up to the limits hitherto assigned for survey, and to carry the advance boundary survey operations into the adjoining district of Shwegyin. It is also intended to execute, on the scale of 64 inches = 1 mile, a survey of the town lands of Thaton, which has been urgently applied for by the Municipality in connection with their contemplated scheme for water-works. A large scale survey (not less than 64 inches = 1 mile) of the town and lands of Moulmein has also been asked for by the Financial Commissioner, as he says, "it is found that large areas of assessed or assessable land fall within the municipal limits, and there are some thousands of revenue-paying grants of peculiar tenure which it is very advisable to locate on accurate maps * * * if possible by the end of next April." Lastly, it is contemplated to execute a topographical survey, on the scale of 1 inch = 1 mile, of the country to the east and south of Mergui, including the coal field near the Tenasserim river. It will be seen that the programme is a very varied one, and it will need the best efforts of every member of the party to ensure its completion.*

DISTRICTS PURI, CUTTACK AND BALASORE, ORISSA.

NO. 8 PARTY.

282. Survey operations in Orissa were resumed early in December 1891 under the charge of Lieutenant-Colonel J. E. Sandeman up to 12th January 1892, from which date Lieutenant-Colonel Sandeman being placed on special duty, pending appointment as Director of Bengal Surveys, the charge of the party devolved on Lieutenant Crichton.

The establishment, of the strength given below, was divided into five sections (two for traverse and three for cadastral operations), and was employed in districts Puri, Cuttack, and Balasore:—

Personnel.

Lieutenant-Colonel J. E. Sandeman, s.c., Deputy Superintendent, 1st grade, in charge from 28th November 1891 to 12th January 1892.

Lieutenant R. T. Crichton, s.c., Officiating Deputy Superintendent, 4th grade, in charge from 11th November 1891 to 28th November 1891 and from 12th January 1892 to 30th September 1892.

Mr. H. R. Littlewood, Officiating Assistant Superintendent, 1st grade, in charge from 1st October 1891 to 3rd November 1891.

„ R. C. Ewing, Extra Assistant Superintendent, 4th grade, in charge from 3rd November to 11th November 1891.

PURI AND CUTTACK CADASTRAL SECTION.

Mr. R. C. Ewing, Extra Assistant Superintendent, 4th grade.

Mr. C. S. Gasper, Sub-Assistant Superintendent, 2nd grade.

2 computers and draftsmen.

Temporary Establishment.

198 computers, draftsmen and *muharrirs*.

28 inspectors.

262 field-surveyors and *khanapuri amins*.

* The Executive Officer speaks very highly of Mr. Littlewood for the able manner in which he managed the detail survey in Tavoy and Mergui under exceptional difficulties. Messrs. Jarbo and Powell are also commended, especially the former, for their energy in the prosecution of the traverse work of these districts in the face of many disadvantages. Mr. Smart is mentioned as unsparing in his efforts to achieve a successful season's work and to be deserving of much credit for his out-turn. Mr. Murphy is said to have afforded valuable help; and Messrs. Gastaud and Biggie are also well reported on. Of the native establishment, the following have been especially mentioned, *viz.*, Nand Lall Chatterjee, Shoshi Bhusan Ghosal, Preonath Banerjee, Dindyal, Faiz Buksh, Sheodat, C. Abrew, Hidayatoola, Nasib Beg, Mahomed Umar, Mohamed Ali, Mahbub Ali, Mahtab Khan, Karim Buksh, Maung Hpo Kah, Dokhine, Pasand Khan and Jukhan Khan.

CUTTACK CADASTRAL SECTION.

Mr. S. O. Madras, Extra Assistant Superintendent, 4th grade.
2 computers and draftsmen.

Temporary Establishment.

Mr. A. H. Pyster, Supervisor.
97 computers, draftsmen, and *muharrirs*.
32 inspectors.
505 field-surveyors and *khanapuri amins*.

CUTTACK CADASTRAL SECTION.

Mr. A. W. Smart, Sub-Assistant Superintendent, 1st grade.
Mr. E. F. Berkeley, Sub-Assistant Superintendent, 1st grade.
Babu Nilmoni Chatterji, Sub-Assistant Superintendent, 3rd grade.
2 computers and draftsmen.

Temporary Establishment.

200 computers, draftsmen, and *muharrirs*.
25 inspectors.
355 field-surveyors and *khanapuri amins*.

PURI AND CUTTACK TRAVERSE SECTION.

Mr. G. Vander Beek, Sub-Assistant Superintendent, 1st grade.
Mr. J. P. Barker, Sub-Assistant Superintendent, 1st grade.
10 sub-surveyors, computers, etc.

Temporary Establishment.

30 sub-surveyors, computers, etc.

CUTTACK AND BALASORE TRAVERSE SECTION.

Mr. G. Campbell, Extra Assistant Superintendent, 4th grade, up to 12th June 1892.
Mr. C. S. Kraal, Sub-Assistant Superintendent, 1st grade.
11 sub-surveyors, computers, etc.

Temporary Establishment.

32 sub-surveyors, computers, etc.

Survey of Puri District.

283. The traverse section commenced field work on the 27th November 1891, and completed the traverse of the district by February 1892. The number of linear miles traversed amounted to 756. Progress was slow owing to the line-clearing work being very heavy.

284. The area traversed includes some unnecessary work done in the early part of the season in *parganas* Bajarkot, Mallud and Parikud, south-east of the Chilka lake. The survey of these *parganas* was notified in the *Calcutta Gazette* of the 26th November 1890, and this notification was not cancelled until the 15th December 1891, before the receipt of which order an area of 41 square miles of traversing in these *parganas* had been completed.

285. The traverses were connected with 13 stations of the Great Trigonometrical Survey and the chain measurements checked thereby. The angular work was checked by observations for azimuth at 32 stations.

286. The cost-rate of the traverse survey was ₹51·6-5 per square mile, and that of the stone embedding was ₹7 per square mile.

287. The cadastral section under Mr. Ewing commenced work on the 3rd December 1891, and completed the area assigned to it on the 1st May 1892. A portion of the section was moved into the Cuttack district in March to commence the area allotted to it there. The area cadastrally surveyed comprises the tract traversed in advance last season, and the 126 square miles traversed this season.

288. The following table gives the out-turn of the traverse and cadastral survey for the season in district Puri :—

DISTRICT.	TRAVERSE SURVEY.				CADASTRAL SURVEY, 16 INCHES = 1 MILE.		
	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Puri . .	278	130	3,905	167	612	451,111	307

The average size of the field calculated on the entire area was 0·43 of an acre.

289. The detail survey was tested by 722 linear miles of check survey, 288 miles being done by Europeans and 434 miles by native inspectors, thus giving an average of 2·3 linear miles of test work to each square mile of survey.

290. The *khanapuri* or record of rights was completed for the entire area cadastrally surveyed and the records handed over to the Settlement Department. Five thousand six hundred and forty-six *khasra* entries were checked by

Europeans of the Survey Department and 6,294 entries by officers of the Settlement Department attached to the camp, as well as 150,782 entries by native inspectors; which gives a percentage of 36 of the total numbers of the *khasra* entries.

All boundary disputes were settled as they came up either by the Survey Officer or the Assistant Settlement Officer.

291. Work was carried on with considerable difficulty in this district. In the *parganas* on the sea-coast the water is brackish and unwholesome; there is a considerable amount of scrub jungle, and the cyclone of 5th November 1891 had destroyed a considerable proportion of the standing crops. Special inducements had to be held out to the *amins* to work in these *parganas*.

292. The area cadastrally surveyed during the season has been mapped on 777 sheets. Of the topographical maps on the 2-inch scale, compiled from the 16-inch plans, six standard sheets of this district have been completed: after examination they will be sent to Calcutta, and it is hoped that the remaining 8 sheets will be completed by the end of November 1892.

293. The cost-rate of the cadastral survey was ₹109-13 per square mile; that of the *khanapuri* amounted to ₹30 per square mile.

Survey of Cuttack District.

294. The two traverse sections, under Mr. G. Campbell and Mr. G. Vander Beek, commenced work in this district on the 28th and 27th November 1891, respectively, and returned to recess quarters on the 30th and 21st June 1892. The first section carried on operations in the Jajpur sub-division, and the approximate area assigned to it was 406 square miles of the Cuttack district. The remainder of the district, *viz.*, 845 square miles, was given to the second section, and both areas were completed.

295. The total area traversed amounted to 1,251 square miles, the number of linear miles being 5,901. The traverse work was connected with fort Barabati, a station of the Great Trigonometrical Survey (the origin of the Orissa survey), and about 196 stations of the main circuit of the irrigation survey of 1878-79 were identified and incorporated in the season's work. The angular work was checked by observations for azimuth at 166 stations.

Permanent marks were embedded at all the traverse stations. These consist of 2,593 large stones, 4,664 smaller stones, 26,147 clay cylinders, and 115 country stones.

296. The cost-rate of the traverse survey was ₹ 32-5 per square mile; that of the stone embedding was ₹5-14 per square mile.

297. The two cadastral sections under Messrs. S. O. Madras and A. W. Smart were employed throughout the season in this district; and a portion of the section under Mr. Ewing commenced work in March 1892 in *parganas* Sailo, Bakrabad and the *parganas* around Cuttack city, where it was joined in May by the remainder of the section from the Puri district. Mr. Madras' area lay principally in the fork formed by the Kendrapara and Taldanda canals, and Mr. Smart's in the Jajpur sub-division.

298. The following table gives the out-turn of traverse and cadastral survey for the season in district Cuttack:—

District.	Traverse Survey.				Cadastral Survey, 16 inches = 1 mile.		
	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Cuttack .	2,388	1,604	33,519	1,251	2,233	1,922,884	1,095

The average size of the field calculated on the entire area cadastrally surveyed was 0·36 of an acre.

299. The detail survey was checked by 4,615 linear miles of test survey, 1,394 miles being done by Europeans and 3,221 miles by native inspectors, thus

giving an average of 4·2 linear miles of check work to each square mile of survey.

300. Heavy floods interfered to a very serious extent with the work in this district. On the 8th, 9th and 10th June, owing to a cyclonic disturbance, there was very heavy rain, more particularly in the north of the district. Messrs. Smart's and Campbell's camps were on the bank of an old bed of the Byturni river, which is usually quite dry; but on the morning of the 11th, the Byturni overflowed and sent a rushing torrent down this old bed, which also overflowed, and in a few hours there were over three feet of water in the camp, and every prospect of its rising higher, which would probably have resulted in the total destruction of the maps and records of the current season's work and all other Government property, representing probably something over three lakhs of rupees value. It was entirely owing to the energy and presence of mind displayed by Mr. Smart that such a catastrophe was averted. Mr. Smart sent immediately for some country-boats, by means of which all the Government property was transported to the high *bund* surrounding the Jajpur town. The gravity of the situation is borne out by the fact that boats of 500 maunds capacity were rowed into the centre of the encampment.

301. The area cadastrally surveyed comprised 298 square miles traversed in advance during last season and 797 square miles of the 1,252 square miles traversed this season, thus leaving 455 square miles traversed in advance for next season, which will be completed in detail and *khanapuri*, and the records handed over to the Settlement Department, by the end of March 1893.

302. With regard to the record writing, of the 1,095 square miles cadastrally surveyed, 781 square miles, comprising 1,519 villages, 1,252,334 fields have been completed in *khanapuri*, and the records of 225 square miles have been handed over to the Settlement Department. The records of the remaining 556 square miles are being completed, and will be all handed over by the 31st October 1892. The 314 square miles which have been cadastrally surveyed this season, but of which the *khasra* entries have not been made, will be completed early next season, and the records handed over by 31st January 1893.

303. Thirty thousand five hundred and fifty-four *khasra* entries were checked by Europeans of the Survey Department, 29,146 entries by Assistant Settlement Officers and 230,389 entries by native inspectors, giving a percentage of 23 of the total number of *khasra* entries.

304. The cost-rate of the cadastal survey in this district amounted to ₹88·13 per square mile; that of the *khanapuri* was ₹35·13 per square mile.

Revision of Irrigation Survey of 1878-79 in Cuttack District.

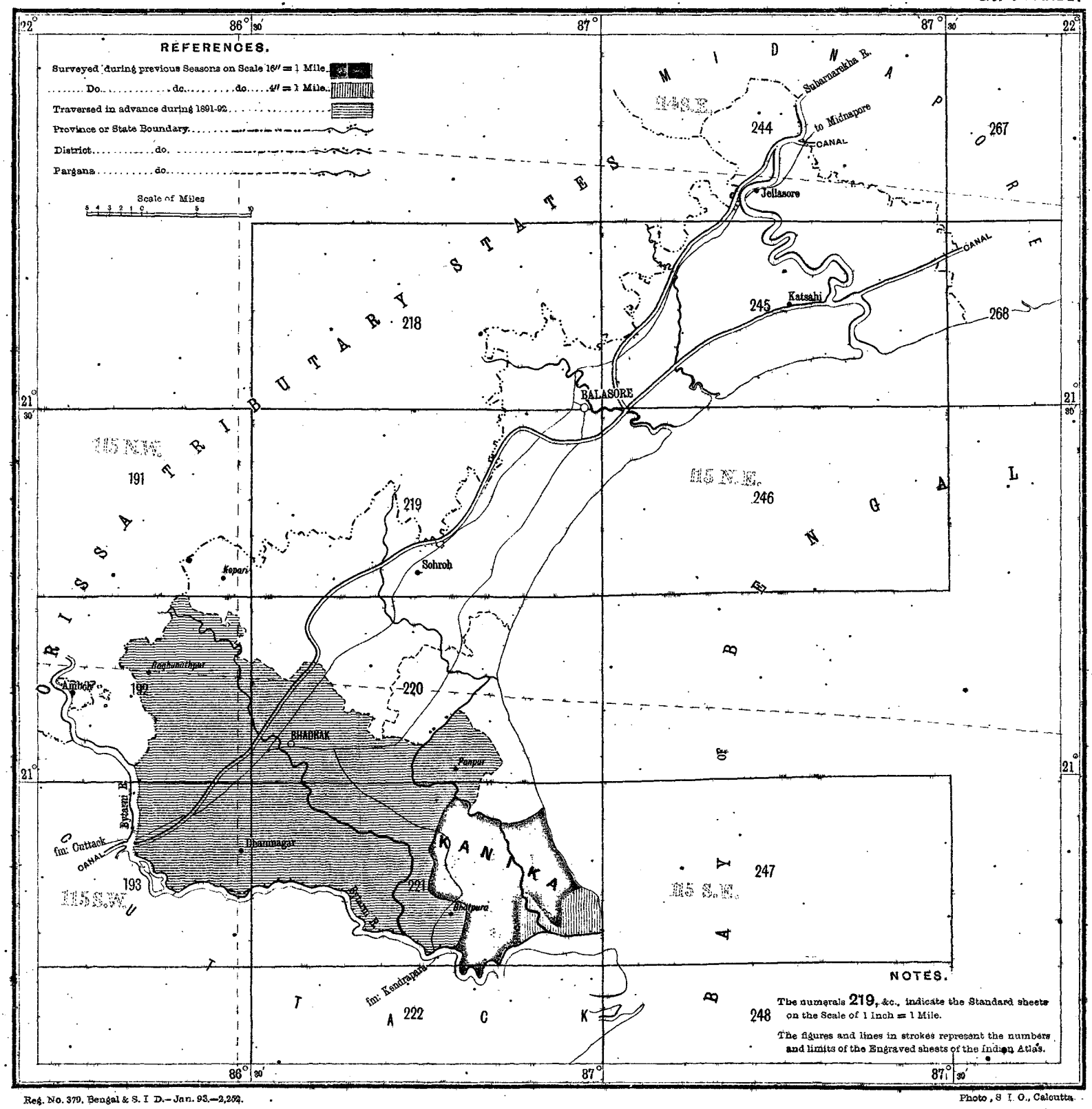
305. This work was commenced concurrently with the ordinary detail survey by Messrs. S. O. Madras and R. C. Ewing. The original orders were that only the correction of the maps was to be done by the Survey Department and that the *khanapuri* would be undertaken by the Settlement, and it was not until the survey of 130 square miles had been corrected (of none of which had the *khanapuri* been done) that it was decided that the Survey Department should do the *khanapuri* as well. This necessitated going over the ground again and caused no little waste of time, and the work was not completed until the end of July 1892.

306. This revision consisted in bringing up the maps to date and doing the *khanapuri* of 364 square miles, surveyed in 1878-79 for the Irrigation Department. The old survey was on the 32-inch scale, and the original unit of survey was the *kitta* (each *kitta* having a number and its area extracted), and there was no distinction made on the map by which the "field" or occupancy of the cultivator could be recognised; nor had the houses in the villages been separated from the fields or compounds. The revision procedure adopted was to give the *khanapuri amin* the map, and he, while he did the *khanapuri*, ascertained which lines on the map denoted the boundaries of a "field" and which the *kittas*; the latter he scored across in red ink and gave a number to the "field." On the traces the *kittas* have been, and on the fair maps will be, shown by dotted lines. In cases where the "field" had not altered since the former survey, the area was obtained by the simple addition of the areas of the *kittas* contained in it, as given in the area statement of the former survey.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF ORISSA, DIST. BALASORE

No. 8 PARTY.



NOTES.

The numerals **219**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Reg. No. 379. Bengal & S. I. D.—Jan. 93.—2,252.

Photo, S. I. O., Calcutta.

Where there were differences—and there were many owing to distributary canals having been cut and the other changes which must be expected in a period of fourteen years—areas had to be re-extracted.

307. When this work was first started, it was not anticipated that it would be so difficult or expensive, but the amount of labour and length of time expended in its completion prove that it is little less arduous than entirely fresh work. It was found necessary to pay the *amins* for the actual correcting of the maps R1·8 per 100 acres, *i.e.*, half of what was paid for entirely fresh survey, and all other items, such as cooly hire, *khanapuri* records, supervision, etc., were of course just as costly as in fresh work.

308. The *khanapuri* of the entire area surveyed in detail was also completed and the records handed over to the Settlement Department.

309. The revised area of 364 square miles is mapped on 2,021 sheets. The average size of the field is 0·27 of an acre. The detail survey was checked by Europeans and inspectors, while engaged in checking the *khanapuri*, by measurements to the corners of fields. The *khanapuri* was checked by the testing of 15,538 *khasra* entries by European officers, 38,397 entries by Assistant Settlement Officers, and 172,958 entries by native inspectors, giving a percentage of 27 of the total number of *khasra* entries.

310. The total expenditure on this work has been R23,146, or R63-9-7 per square mile, but it is estimated that a further sum of R6,000 will have to be expended to complete the final records, etc.

Survey of Balasore District.

311. The operations in this district were confined to traverse work. The traverse section under Mr. G. Campbell on completion of its area in the Cuttack district commenced work in Balasore in March and closed work at the end of June 1892.

The following table gives the particulars of the area traversed :—

District.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Balasore	1,072	963	13,938	588

312. The number of linear miles traversed was 2,905 : connection was made with one station of the Great Trigonometrical Survey to test the chain measurements, and the angular work was checked by observations for azimuth at 71 stations. Permanent marks have been embedded at all the traverse stations, and consist of 1,380 large tri-junction stones, 1,880 smaller stones, and 10,678 clay cylinders.

313. Some opposition was met with in this district, owing to the delay in the publication of the Government notification of survey, and there was a good deal of cholera in the district towards the close of the field season. There is believed to be an area of 1,100 square miles remaining to be traversed in the Balasore district. This will be completed next season.

314. There was, at the close of the field season, an area of 750 square miles undemarcated. It was decided that the Survey Department should demarcate this. This work has been commenced, and it is hoped that it will be completed by November 1892.

315. The cost-rate of the traverse survey was R17-11 per square mile; that of the stone embedding was R6-8 per square mile.

General remarks applicable to the three districts.

316. The unit of traverse survey was the "existing" *mauza*, *i.e.*, the *mauza* as pointed out by the people on the ground, and in contradistinction to the *mauza* of the former revenue survey.

All traverse work was plotted roughly on the 4-inch scale, and comparisons were made with the old 4-inch village maps of the former survey, and wherever

any differences appeared, they were noted for the information of the Settlement Department.

All *tahsil alahida* blocks over 50 acres in area were also traversed round, but not plotted separately, *i.e.*, they were plotted and surveyed with the village in which they lay.

317. The demarcation was done by the Settlement Department, and consisted of erecting bamboo sticks with small earthen mounds at their bases at the tri-junctions and salient points on the village boundaries. A large number of these marks were not forthcoming at the time of traverse survey, which delayed the sub-surveyors and line-cutters not a little. These marks had probably been washed away by some of the numerous floods to which the Orissa division is subject.

318. Permanent marks of the same description as used in former seasons were obtained from a contractor at the rates of ₹56-4 per 100 for large stones for tri-junction of boundaries and ₹37-8 for the smaller stones. These rates included carriage to any centres that might be named to the contractor. Baked clay cylinders are obtainable almost anywhere in the district at an average rate of ₹4 per 100. At the commencement of the season, the smaller stones were embedded at the satellite stations of each tri-junction; but early in the season orders were given that these smaller stones should be embedded at stations at intervals of about 40 chains, taking care that each stone should be placed in such a manner that the stations in advance and behind it might be visible. The object of this procedure was to place the smallest number of stones compatible with the necessity of being able to relay the boundary with a plane-table in the event of the cylinders having been destroyed.

319. The 16-inch scale was found generally large enough for the survey, except for the village sites, which are very close and among which the fields are very diminutive, and as each house had to be shown separately, it was generally found necessary to make an enlargement on the 32-inch scale of these portions on the margin of the sheet. The survey of the village sites is in Orissa a difficult matter, as the majority of the villages are surrounded by bamboos, palms, etc., and at a little distance present more the appearance of a dense wood than a village: this often necessitated having theodolite stations running close round the sites.

320. The unit of cadastral survey was the "field;" *kittas* (interior sub-divisions of fields for purposes of irrigation and agriculture) were not measured or mapped (except in the revision area, where they were shown at the request of the Irrigation Department), but the total number of *kittas* contained in a holding were noted in the *khasra*.

321. Lieutenant Crichton reports that the expense and delays in work in Orissa are primarily due to the nature of the inhabitants of the country. The Uriyah will do no more work than he is absolutely obliged to do in order to obtain a bare living. It is only by the closest supervision and constant coercion that the Uriyah *amin* can be prevailed upon to produce a moderate daily out-turn of work. As a surveyor his laziness makes him practically useless; his rate of work has been proved to be this season one-fifth of that of an up-country *amin*; his drawing is most clumsy, and a map which has been in the hands of an Uriyah *amin* is returned in a dirty and very often torn state to the camp office. Another cause of expense in Orissa is no labour being given free by the villagers (as is the case in the Upper Provinces). Each cooly had to be paid 1 anna or 2 annas a day, according as he was working in his own village or outside it. As each *amin* requires about five coolies, it is evident that cooly hire is a very expensive item in Orissa, more especially so when the field surveyor is an Uriyah. The Uriyah *amin's* out-turn being 6 acres a day, and 5 or 6 annas being paid for his coolies, the cooly bill alone adds one anna per acre. In order to reduce the expenditure on detail survey, this branch of the work was gradually, to a great extent, handed over to up-country *amins*, the Uriyahs being employed on the *khanapuri*. The complete indifference displayed by the inhabitants to the survey was another and very serious cause of delay and consequent expense.

322. The difficulties experienced in preparing the record of rights have been very great during this season for the following reasons:—

Firstly.—The slow rate of work of the Uriyah.

Secondly.—The number of changes in procedure during the field season. No less than four different forms of *bhowriah* (*khasra*) and three different forms of *warijah* (*khatian*) were successively brought into use during the field season.

Thirdly.—Although the Settlement Department at the commencement of the season were supervising the *khanapuri*, no distinct instructions were received as to the filling up of the records until the Director of Land Records visited Orissa, when on the 26th March 1892 a *hidayatnama* was published; but it was not till the 1st June 1892 that Uriyah translations of these instructions, although repeatedly called for, were received from the Settlement Department.

Fourthly.—Almost throughout the entire area of *khanapuri* no draft *khewats* had been prepared by the Settlement Department; they had therefore to be prepared by the Survey Department and compared with the A, B, and C registers of the collectorate. In some *parganas* draft *khewats* had been prepared *mahalwar*; but these were practically useless, as they had to be converted into *mauzawar*. In addition to this, there was great delay in the supply of the *khewat* forms: some parts (I and III) were not received till the 8th and 12th August 1892.

Fifthly.—With some exceptions, the *khanapuri* officers supplied by the settlement to aid in the supervision of *khanapuri* and settlement of disputes were quite inexperienced, and had to be taught their duties. Until they had learnt their work they did not help greatly.

Lastly.—The establishment of *khanapuri amins* necessary for the large area required could not be obtained.

323. Messrs. Smart and Ewing speak very highly of the help rendered them by Mr. James Taylor and Babu Chakoo Lal Sircar, Assistant Settlement Officers, attached to their camps.

324. The health of the party was on the whole very good, notwithstanding the lateness of the field season. Cholera broke out among the *khalásis* obtained from Hazaribagh on their arrival in Cuttack, and there were several deaths. Cholera was present throughout the district the entire field season, and at times assumed severe proportions, more especially so in the Jajpur sub-division, in which there were 2,330 deaths from this cause; and in the Jagatsingpur *thana* there was also at one time a rather severe epidemic of small-pox. About thirty menials of the temporary establishment died from the above causes. These epidemics interfered not a little with the progress of the work, as it was with the greatest difficulty that the *amins* and *khalásis* were prevailed upon to remain in the district, and the camp officers had to be continually arranging for the transfer of squads from villages where work was in progress, but where cholera had broken out, to other villages which had not so far been attacked. The uncompleted villages were completed after the cholera had abated.

325. In addition to the areas already reported as cadastrally surveyed, certain arrears of the previous season have been completed: 6 square miles, representing portions of 52 villages not completed last season, were surveyed in detail, and the *khunapuri* of 52 square miles, containing 93 villages which remained to be done, was also carried out.

The records of 541 villages of last season's work have been completed and handed over to the Settlement Department, and the records of 32 villages which still remain will be handed over during October 1892. The whole of the records of Killa Kanika have been completed and despatched to the Settlement Officer.

326. The survey of Cuttack city on the 64 inches=1 mile scale has been commenced; it is hoped that this will be completed by the end of next field season.

327. The average cost-rate of the season's work for the complete operations done in the Orissa division, comprising stone embedding, traverse and cadastral survey, *khanapuri* and completion of records, is ₹157-0 per square mile against a rate of ₹179 in the previous season, thus showing a saving of ₹22 per square mile. The real savings on the new work effected during the season is however greater than this, as the rate of ₹157 includes the expenditure incurred

in completing the arrears of the previous season. It is anticipated that the mileage-rate will be still further reduced during the ensuing season.

328. Lieutenant R. T. Crichton has conducted the extensive and difficult survey operations in Orissa with considerable ability.

329. The programme for the ensuing season comprises the traverse survey of the area remaining in the Balasore district, estimated at 1,100 square miles; the cadastral survey and *khanapuri* of 455 square miles in Cuttack completing that district, and of 1,045 square miles in Balasore.

There will then remain an area of 645 square miles for cadastral survey in the Balasore district for the season of 1893-94 to complete the operations in the Orissa division.*

PROME DISTRICT, LOWER BURMA; MINBU AND MAGWE DISTRICTS, UPPER BURMA.

No. 12 Party.

330. This party, which was previously employed on traverse survey operations in Lower Burma, was transferred to Upper Burma to take up cadastral work in district Minbu. Mr. F. Grant held charge of the party till the 18th November 1891, when he was relieved by Mr. W. H. Patterson, who has continued in charge for the remainder of the year. The party left Rangoon on the 15th November and arrived in the Minbu district on the 19th idem, where survey operations were commenced with the establishment noted in the margin. For convenience of survey three detachments were formed, each being so constituted as to admit of traverse work being started at three centres to expedite the plotting of sheets for detail survey, as no traverse work had been prepared in advance.

Personnel.

Mr. W. H. Patterson, Deputy Superintendent, 1st grade, in charge from 19th November 1891.
„ F. Grant, Officiating Deputy Superintendent, 2nd grade, in charge up to 18th November 1891.
„ A. E. Spring, Officiating Assistant Superintendent, 1st grade.
„ W. S. Buttress, Extra Assistant Superintendent, 1st grade.
„ E. G. Little, Extra Assistant Superintendent, 2nd grade.
„ J. S. Swiney, Extra Assistant Superintendent, 4th grade.
„ W. E. Johnson, Sub-Assistant Superintendent, 2nd grade.
„ T. W. Babonau, Sub-Assistant Superintendent, 2nd grade, up to 29th June 1892.
„ F. S. Bell, Sub-Assistant Superintendent, 2nd grade.
24 sub-surveyors and others.

Temporary Establishment.

70 inspectors, draftsmen, computers, etc.
114 field surveyors (Indian).
32 Ditto (Burman).

331. The programme for the field season consisted of—

(*a*) the revision of 112 square miles of traverse survey in district Prome;
(*b*) the traverse and cadastral survey in district Minbu; and
(*c*) advance traverse survey in district Magwe.

332. Field work was closed between the 16th and 20th of July, and the recess office opened at Mandalay on the 25th idem. A few sub-surveyors were kept out during the rainy season in order to push on the traversing in Magwe, so as to ensure having a sufficient number of plots for the field surveyors to commence work on in November 1892; fortunately the rainfall was not heavy and, the ground being on a high level, they were enabled to carry on their work without any very great difficulty.

Traverse Survey of Prome District.

333. It was found that of the traverse area surveyed in 1890-91, 43 *kwins*, embracing an area of 112 square miles, required revision. This was entirely

* Messrs. R. C. Ewing, S. O. Madras and A. W. Smart, in charge of cadastral sections, and Messrs. G. Vander Beek and C. S. Kraal, in charge of traverse sections, deserve credit for the manner in which they managed their sections and for the large arrears accomplished in the face of considerable difficulties.

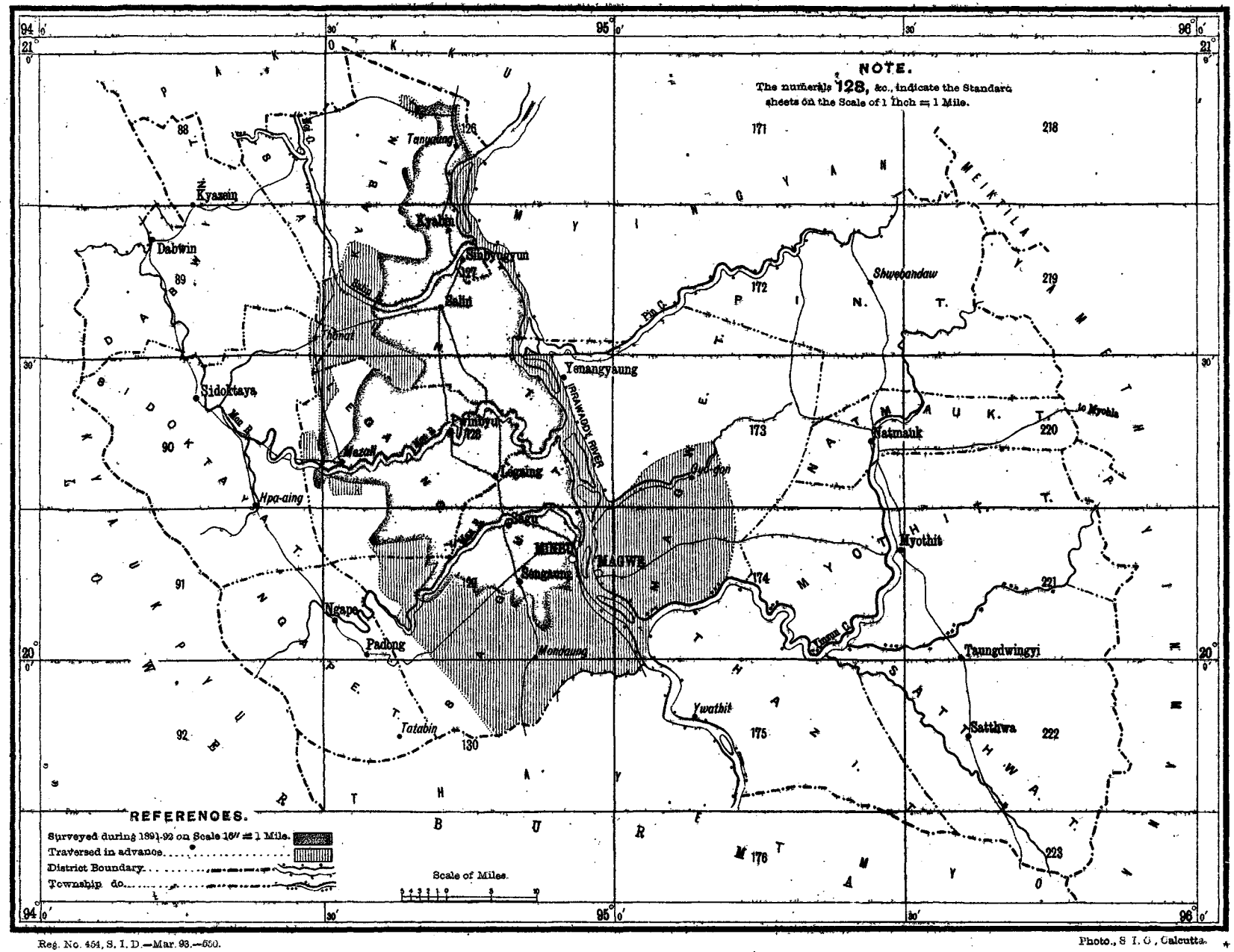
Lieutenant Crichton expresses himself particularly indebted to Messrs. R. C. Ewing and A. W. Smart, whose long experience in cadastral operations he has found most valuable. Messrs. E. F. Berkeley, J. P. Barker and C. S. Gasper, and Babu Nilmoni Chatterji are all reported to have worked hard and well, and to have given valuable assistance to the officer in charge of their sections.

He also reports very favourably on the way Mr. Pyster, Supervisor on the temporary list, has worked. The following members of the native establishment are worthy of mention: Raghubir Saran, Lalji Sahai, Sheo Narain, Manohar Lall, Bindbasni, Imam Ali, Ishri Pershad, Kalka Pershad, Joghobundu Kanungo, Fariduddin and Jawala Pershad.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. MINBU & MAGWE.

No. 12 PARTY.



Reg. No. 454, S. I. D.—Mar. 93.—650.

Photo., S. I. G., Calcutta.

owing to the difficult and unsuitable ground over which the traverse survey had to be taken in order to follow closely the boundaries of *kwins*. The completion of the work took longer than was anticipated, owing chiefly to the difficult nature of the ground, to sickness, and to delays in finding the survey stations. The clay cylinders which had been used to mark the stations were in some cases found to have been uprooted, and this necessitated the fixing of new stations. Altogether it took longer to revise this work than it would have done to make an entirely new survey.

334. The following is a statement of the revision work done:—

District.	Traverse Survey.		
	Number of *kwins*.	Number of skeleton plots.	Area in square miles.
Prome	43	111	112

The survey stations were marked with burnt clay cylinders, and notices containing skeleton plots of the village polygons, showing the positions of the theodolite stations, were prepared on the 4-inch scale, and one copy furnished to the *kyedangyis* and one to the Deputy Commissioner.

335. Skeleton plots, on the scale of 16 inches to the mile, of 43 *kwins* on 111 sheets and copies of area tables were furnished to the Superintendent of the local field-to-field survey during the field season, and in the recess months 2-inch plots of the north-east and south-east sections of standard sheet No. 225 were also furnished to that officer for the purpose of inserting thereon the topographical details obtained from the local cadastral survey. The Superintendent was further supplied with certain data of traverse work done in previous years by this party for incorporation with the work to be undertaken by the supplementary survey in the area left unsurveyed by the traverse professional party, and which is referred to in paragraph 336 of the General Report of 1890-91.

336. The records in connection with the traverse work of the present and past seasons' surveys have been completed; the volumes have been bound, indexed and paged, and after final examination will be despatched to the Head-Quarters Office, Calcutta.

Cadastral Survey of Minbu District and Traverse Survey in Magwe District.

337. In consequence of heavy rain in the latter part of November, field work did not fairly commence until the 1st December. The demarcation of the circle boundaries was found ready by the time the survey party arrived, and guide maps of townships, showing roughly the boundaries of circles, were furnished by the Deputy Commissioner, who was the boundary officer; under him a *myook* was appointed as demarcation officer, and he carried on the demarcation of the circle boundaries. The demarcation of the lands forming village areas was unfortunately not done, and this omission was brought to the notice of the Deputy Commissioner in December, when orders were issued for the demarcation of the *kwins* or village boundaries in each circle. The want of the *kwin* boundaries delayed traverse operations somewhat during the early part of the season, as, after the circle boundaries were surveyed, the sub-surveyors had to go over the ground a second time for the traverse surveys of the *kwin* boundaries. Wooden posts were placed by the demarcation officer along the boundaries at salient points Afterwards, in consultation with the Deputy Commissioner, cairns of stones were placed at the base of each post, and where stones were not available bricks were heaped up, and thus some attempt was made to ensure the boundaries being permanently marked. The average size of the circle is 5,606 acres, that of the *kwin* is 1,747 acres. All boundary disputes brought to the notice of the Survey Department were referred to the Deputy Commissioner for disposal.

338. The out-turn of work is given in the following table arranged by townships, both as regards traverse and detail survey :—

Districts.	Townships.	Traverse Survey.		Cadastral Survey, 16 inches=1 mile.		
		Number of *kwins*.	Area in square miles.	Number of *kwins*.	Number of fields.	Area in square miles.
Minbu	Kyabin	81	163	64	78,757	111
	Legaing	111	296	102	113,732	249
	Segu	118	483	95	129,177	216
	Salin	153	331	136	233,245	208
	Sedoktaya	9	15	...	...	...
Magwe	Magwe	47	156	...	...	...
	Total	919	1,444	397	554,911	784

339. The cadastral area forms a compact block, extending from the Irrawaddy to the foot of the hills, and all the cultivable waste, as well as the cultivated, lands has been brought under traverse survey. The total area of the district is estimated at 2,800 square miles, of which 1,230 are covered with hills and are not for survey at present, leaving an area of about 1,570 square miles of cultivable or cultivated lands for survey, of which 784 have now been completed. Of the area surveyed, about 548 square miles are cultivated and 236 square miles uncultivated. The average size of the field on the whole area is 0·90 of an acre, but excluding uncultivated tracts it is 0·66 of an acre in irrigated and 1·26 of an acre in unirrigated tracts. In addition to the usual field survey, special plans of the Municipalities of Minbu and Salin were prepared on the 16-inch scale.

340. The number of linear miles traversed was 4,086. Two chains—one of 100 feet and the other of 66 feet—were used to ensure accuracy. Baked clay cylinders were not used for marking the traverse stations this year. As an experiment, zinc or corrugated iron sheets were introduced with the concurrence of the Director of Land Records. The zinc sheets were cut into strips of 18 inches in length and 10 inches in width, and bent round into a tube; the lower end of it was slit up for an inch in three or four places and turned up at right angles. This was to prevent the tubes from being easily pulled up after being embedded in the ground. The tubes were tarred to prevent them from rusting. The advantages in using the zinc tubes are—

(*a*) that they are light and portable;

(*b*) that they cost less than baked clay cylinders;

(*c*) that the transport charges are considerably reduced owing to one man being able to carry more zinc tubes than clay cylinders; and

(*d*) that there is no breakage, as is the case with clay cylinders.

The advantages mentioned above have been realized, but it is to be seen if the tubes will be as durable as clay cylinders. During the ensuing season some tubes will be taken up to examine their condition and to see how they have stood the rainy season. All the theodolite stations, numbering 26,879 in this season's work, have thus been marked with zinc tubes; the average number of theodolite stations, permanently marked in a square mile, is 19, and the cost of marking them per square mile is R3-13-11. Under the Upper Burma Boundaries

Act, notices signed by the Deputy Commissioner have been served on the *thugyis* for the preservation of the theodolite stations permanently marked. A separate notice for each *kwin* was issued, and on each notice a 2-inch skeleton plot was prepared, showing the survey lines and the theodolite stations. One copy was retained by the *thugyi* and the duplicate copy was made over to the Deputy Commissioner. During survey operations none of the survey stations were found to have been disturbed by the villagers.

341. Of the detail area surveyed, 673 square miles were completed by field surveyors from India and 111 square miles by Burmans. The work done by the latter proved on the whole to be good, and only in a few instances was it found necessary to reject portions of field sheets. One Burman inspector and a squad of ten field surveyors, who had worked in No. 7 Party in Lower Burma in the previous year, were transferred to this party, and their out-turn compared favourably with that of field surveyors from India. The average monthly earnings of the Burman surveyors was R25-2-4, and that of the Indian surveyors was R33-0-11, whilst the highest amount earned by a Burman in one month was R38-1-2, as against R47-9-8 earned by an Indian surveyor. In cultivated tracts a trained Burman surveyor will turn out a very good area, not much behind that of a surveyor from India; but it is in surveying fields scattered in jungle that the Indian excels and gets over a larger area: this is due to the Burman not being able to endure the fatigues and exposure to which the Indian from experience and training is accustomed.

342. The field work was tested by check survey lines run by inspectors as the survey progressed, followed by test lines run by the European assistants as the sheets were completed. Three hundred and seventy-three linear miles of test survey were run by Europeans, 1,101 linear miles by inspectors, and 287 linear miles by independent native *partallers*, giving an average of 2·25 linear miles to a square mile of detail survey on the whole area surveyed. The work proved to be, on the whole, very good; the only exceptions were occasionally in uncultivated parts, where the field surveyors were somewhat careless in putting in the cart tracks and streams.

343. The season's detail area is mapped on 951 sheets of the 16-inch scale survey. The drawing of the sheets is well advanced, and will be completed during December. Tracings of the same for the Settlement Department are under preparation and near completion. The field area statements to be furnished with the tracings for the Settlement Department are also well advanced. There is now ample work completed and ready to be made over to the Settlement Department as soon as an officer is appointed.

344. A few of the Burmans (from Lower Burma) who were employed as field surveyors have aided in the preparation of the original sheets, and the work done by them, *viz.*, inking in details and inserting field numbers, is satisfactory. Most of the tracings for the Settlement Department have been prepared by Burmans, and they have also taken a share in calculating the field areas. A few trained local men, who worked as field surveyors under Mr. R. A Gibson, Extra Assistant Commissioner in charge of the local surveys at Mandalay, were made over by that officer for employment in preparing tracings and taking out areas. These men have done good work and will be employed as field surveyors during the ensuing season.

345. The total expenditure for the survey year has been R2,16,426. After deducting the cost of the recess establishment for October and part of November 1891, and the cost of the revision surveys in Prome, the sum of R2,05,796 remains; of this, R1,97,302 represents the cost of the traverse and detail surveys in Minbu, and R8,434 that of traversing in Magwe. The cost-rates per square mile deduced from this are R57-12 for traverse and R156 13 for the detail survey. These rates include the cost of the transfer of the party from Lower to Upper Burma. They may be considered very satisfactory, more especially when it is considered that there was a certain amount of extra expense due to the partial famine in the district.

346. In order to reduce the great expense of importing all the *khalásis* from India, the Commissioner and Deputy Commissioner were consulted as to the feasibility of obtaining a certain amount of local labour to assist the field surveyors in chaining and in carrying instruments. It was decided that each

Hindustani *amin* should be allowed to bring two men with him from India, and that the other two men he required should be supplied locally, the local men to be paid 4 annas a day. The *thugyis* provided the men, and advances were made to them so as to allow of the wages being paid daily. The accounts were finally settled by the camp officer when the survey of the villages forming a *thugyi's* circle was completed. Only in a few villages was there any difficulty in obtaining local labour. The *amins* did not approve of this system, as the men were very apt to be late in coming to work, and the constant change of men interfered with the steady progress of the work: this was of course a disadvantage to men who were working on the contract system. The Burman field surveyors worked entirely with local *khalâsis*. Enquries were made by the Deputy Commissioners and by the inspecting officers when travelling as to whether the *thugyis* were regular in their payments for local labour, and it was found that with very few exceptions they were so. The total sum spent in wages to local *khalâsis* amounted to ₹11,265, which was no doubt of some assistance to the people, who were more or less pinched for food in consequence of the high prices. The villagers willingly rendered help to the surveyors, and notwithstanding a little difficulty in consequence of the strange language, great harmony prevailed between the Indians and the Burmans.

347. The health of the establishment has been good throughout the season. There was a certain amount of sickness at the beginning and at the end of the season, but nothing of a serious nature.

348. The area remaining for survey in Minbu is about 506 square miles. Besides this, there is an approximate area of 280 square miles, consisting of narrow strips of cultivation running along the valleys of the Mon, Man and Salin rivers, which the Chief Commissioner has decided should be omitted at present, it being more to the interests of Government to utilise the survey party on the large compact areas in Minbu and Magwe than in these smaller and scattered areas. There will therefore during next field season be one cadastral camp employed in these 506 square miles in Minbu, whilst there will be a second which will complete a similar area in Magwe. In this district it is proposed to complete the Taungdwingyi sub-division in the first place, extending the work northwards into the irrigated lands of the tracts drained by the Yeu river and its tributaries. The total area of the Magwe district is said to be 3,250 square miles, of which only 2,300 square miles are for cadastral survey.

349. Messrs. Hartnoll and Eales, the Deputy Commissioners of Minbu and Magwe, both rendered much assistance to the party. Mr. Hartnoll took a personal interest in the work, and much of the success of the party, in turning out so large an area during its first season, is due to the ready help afforded by him and by the Sub-divisional Officers of Salin and Pwinbyu.

350. On the 23rd June, the Financial Commissioner, acccompanied by the Deputy Commissioner, inspected the party. The Chief Commissioner also visited the camp at Minbu on the 13th July, and again inspected the recess office at Mandalay on the 22nd August, when he was accompanied by the Deputy Surveyor-General. The season's work and the office itself was thoroughly inspected by the Deputy Surveyor-General on the 24th and 26th August. The office books and records were found in good order; the main circuit traverse observations were neatly recorded, as were most of the village traverses; directions were given that more conspicuous objects, such as pagodas, etc., should be connected with the traverse lines. Several independent *partal* lines were examined with the field sheets and were found to be quite satisfactory. The Deputy Surveyor-General considers that Mr. Patterson deserves credit for the amount of work his party has completed during this its first year of cadastral work in Upper Burma.

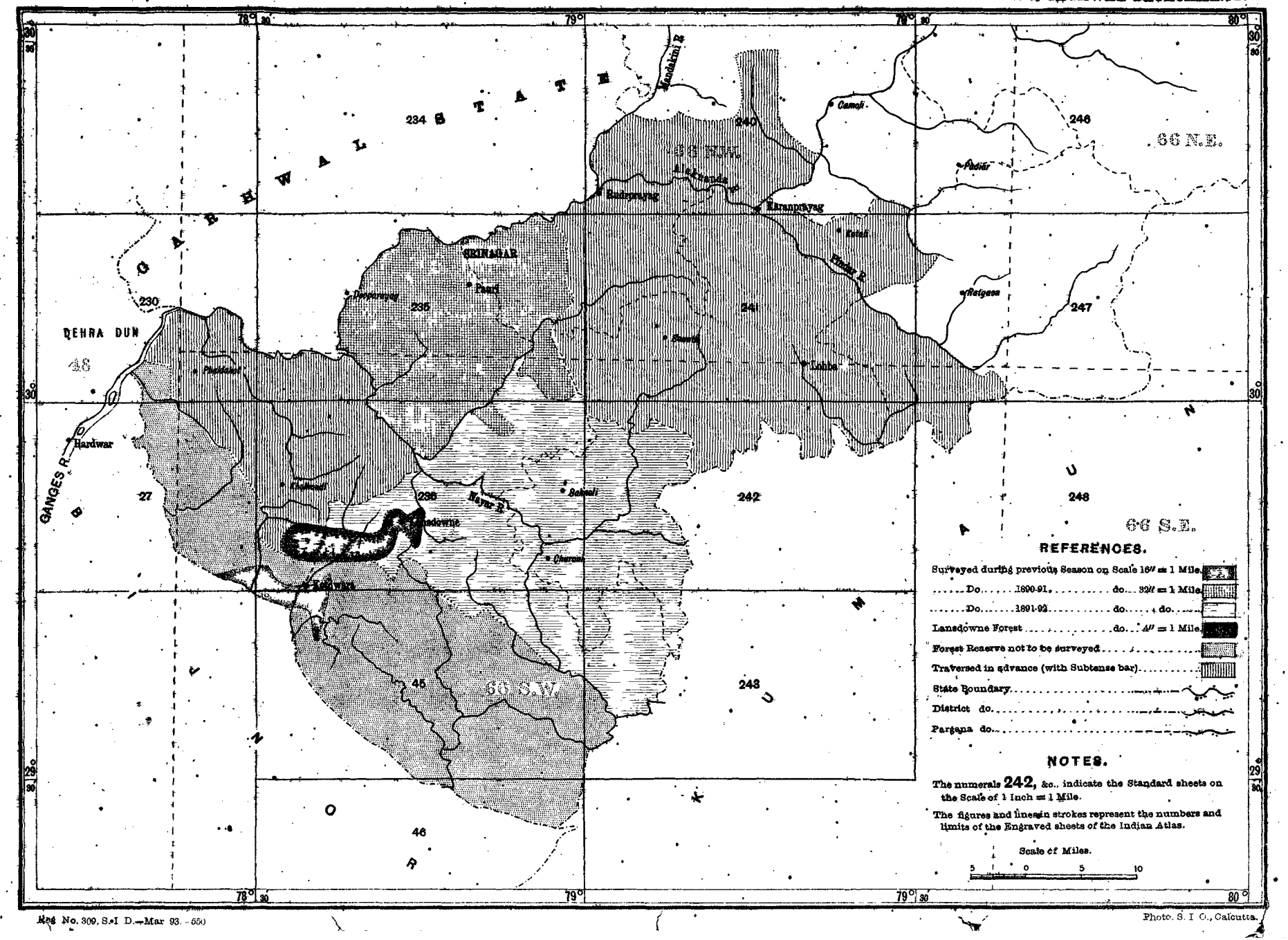
351. Mr. A. E. Spring, Assistant Superintendent, conducted both cadastral and traverse operations, and held charge of a camp office in the field and in recess. He is reported to have performed his duties in a very satisfactory manner.*

* Mr. Patterson thus reports of his assistants: Messrs. Buttress and Little, who were in charge of camps, are experienced and hard-working officers. Mr. Swiney is especially mentioned for his large and satisfactory out-turn of field work. Messrs. Babonau, Johnson, and Bell have all worked well. Of the native establishment he mentions the following as deserving of praise: Rajendra Chatterjee, Abdul Rahman, Rhedoy Chunder Dass, Jogendra Chunder Ghose, Moti Lall, Laximan Kadekar, Abdool Wahid, Tufail Ahmed and Makbool Hossein.

N. W. PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. GARHWAL.

No. 5, GARHWAL DETACHMENT.



REFERENCES.

Surveyed during previous Season on Scale 16″ = 1 Mile.
Do. 1890-91. do. 32″ = 1 Mile.
Do. 1891-92. do. do.
Lansdowne Forest do. 4″ = 1 Mile.
Forest Reserve not to be surveyed.
Traversed in advance (with Subtense bar).
State Boundary.
District do.
Pargana do.

NOTES.

The numerals **242**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

5 0 5 10

Map No. 309, S.I D.—Mar 93.—55)

Photo. S. I. O., Calcutta.

GARHWAL DISTRICT, NORTH-WESTERN PROVINCES.

DETACHMENT OF NO. 5 PARTY.

Personnel.

Mr. T. F. Freeman, Extra Assistant Superintendent, 1st grade, in charge.
„ N. Bedford, Sub-Assistant Superintendent, 1st grade.
„ W. Skilling, Sub-Assistant Superintendent, 2nd grade.
„ T. H. Murphy, Sub-Assistant Superintendent, 2nd grade.
12 sub-surveyors and others.

Temporary Establishment.

18 inspectors.
12 field surveyors (Hindustanis).
198 field surveyors (local).
210 estimators, draftsmen and *muharrirs*.

352. Operations were resumed by this party in the Garhwal district on the 21st October 1891 and were continued until the 11th June 1892, when the drawing, estimating, and traverse sections proceeded to recess quarters at Naini Tal, whilst the vernacular records, under Mr. N. Bedford, were taken to Pauri. Recess work was not commenced at the latter place till the 24th June, as sufficient coolies could not be procured to convey the records, etc., thither until the Deputy Commissioner threatened to suspend the *patwári* responsible for providing the necessary transport.

353. The strength of the establishment is shown in the margin. The number of imported *amins* employed was considerably less than during the previous season, as owing to the dislike they took to the district in consequence of the inconveniences they had to put up with from the physical difficulties, inclemency of the climate, and the fatigue they had to undergo while surveying, not half the old staff returned. This having been anticipated, arrangements had been made to train a number of hill *amins* at Pauri during the recess season of 1890-91, so that the deficiency in the strength of the establishment was made good by the employment of a greater number of local men.

354. The system of traverse by the bar-subtense method described in paragraph 228 of the General Report for 1889-90 was continued. The azimuths and rectangular co-ordinates of the trigonometrical stations which formed the starting and closing points of the traverses furnished the data for these traverses. Theodolite stations were fixed all over the cultivated area at distances of 15 to 25 chains apart. The traverse stations have all been marked by triangular cuttings on rocks *in situ*, or by rough uncut stones embedded in the ground and covered with mounds of loose stones. Receipts have been taken from the village *padhans* for the same.

355. The traverse survey includes the remaining *pattis* of *parganas* Ganga Salan, Dewalgarh and Chandpur, and portions of *parganas* Nagpur and Badhan. As the Government of India have decided not to extend survey operations into the northern or less accessible *parganas* of the district, three of the *pattis* already traversed will not be surveyed cadastrally.

356. The following statement gives the out-turn of the season's traverse work :—

Parganas.	Traverse Survey.			
	Number of main traverses.	Number of sub-traverses.	Number of stations.	Area in square miles.
Ganga Salan Dewalgarh Chandpur Nagpur Badhan	90	646	12,069	578

The traverses emanated from and closed on 172 trigonometrical stations. The angle subtended by the bar from which the distances between stations are obtained was generally observed 20 times to ensure accuracy in the deduced measurements. The heavy fog during the winter months and dense haze in the latter half of the field season constantly prevented the observations being made to the more distant trigonometrical stations, thus preventing final connections being effected and causing considerable delay.

357. The cost of the season's out-turn in traversing amounts to ₹17,480, giving a rate of ₹30-4 per square mile.

358. The cadastral survey, which is being carried out on the 32-inch scale owing to the small size of the fields, included the remaining *pattis* of *parganas* Chaund Kot and the whole of *parganas* Malla and Talla Salan, with the exception of 11 villages which were left incomplete owing to an outbreak of cholera in them. The details of the season's out-turn is shown in the following table :—

Parganas.	Cadastral Survey, Scale 32 inches = 1 mile.			
	Number of *pattis*.	Number of villages.	Number of fields.	Area in square miles.
Chaund Kot Malla Salan Talla Salan	26	1,500	962,441	231·5

The area surveyed includes small patches of intervening waste, and it is estimated that at least 157 square miles will be classified as assessable land, whilst at the time of last settlement only 65·5 square miles were assessed in these three *parganas*. The average size of the field, calculated on the total area surveyed, is 0·154 of an acre and 0·104 on the assessable area. The total area includes the scattered patches of village lands within the Lansdowne forest reserve. These isolated plots are demarcated by masonry pillars, and the boundaries are supposed to run in straight lines between the pillars. From the nature of the ground it is impossible to say exactly where these lines run, and now that the cultivated lands of these villages have been mapped, it has been found in many cases that portions of fields in the possession of villagers lie outside these lines. The question as to what is to be done in these cases has been referred to the Commissioner of the division for orders.

359. The cost of the detail survey and *khanapuri* of the area surveyed this season amounts to ₹42,302, giving rates of ₹182·11 per square mile, Ro-4-7 per acre, and Ro-0-8 per field, which are very considerably less than those of last year. The reduction in rates is chiefly due to the increased rate of progress made by the *amins* and to the reduced pay granted to local *mirdhas* and *khalásis*. The details of the cost are given in the statement at page 86.

360. There were 268 boundary disputes, which were referred to the Settlement Department for decision. Unfortunately no Deputy Collector was available for the settlement of these disputes till March. He had scarcely begun deciding them when he was called away to district work in connection with famine relief and the outbreak of cholera in the *parganas* under his control. Of the 268 boundary disputes, only 13 have been decided up to date, thus rendering it impossible to finally complete the maps and records of 510 villages. Disputes are generally decided according to present possession, as the old settlement maps are mere sketches, not even drawn to any scale, and afford very little assistance in adjusting the claims of the parties concerned. It is very difficult at times to arrive at the truth as to who is in actual possession, as both sides persistently maintain that they are and produce witnesses to prove it.

361. Partitions in fields are usually marked by small slabs of stone 6 to 9 inches long and 4 to 6 inches wide. They are called *odas* and are easily and frequently removed, thus creating numerous disputes at the time of *khanapuri*. At the time of survey these divisions were pointed out quite differently to what they were at the time of writing the *khanapuri*, thus necessitating frequent erasures in the original maps, which is objectionable. The unit of measurement is the field, as defined by the Board of Revenue in its "Directions to Settlement Officers." All terraces within fields have been approximately shown in their respective positions by faint dotted lines; and the number of terraces in each field has been recorded in the column of remarks of the *khasra* to enable the estimator to calculate and allow for the area of the terrace walls at a certain fixed rate per length of terrace. The extraction of field areas in this district is consequently a much more laborious task than usual, as, owing to the very small size of the fields, areas have to be extracted to the third place of decimals of an

acre, and in addition to this the deduction has to be made for all interior terrace walls; the deduced area, both in acres and in the local denominations (*nalis* and *annas*), has then to be recorded opposite each number in the settlement records.

362. The procedure in preparing the record of rights adopted in the previous season was adhered to with slight modifications. The ownership of trees, which at first it was considered unnecessary to record, has been entered during the present season in accordance with orders from the Board of Revenue. *Khatauni* slips or *parchas* (separate lists of all fields held by each cultivator) were prepared on the ground at the time of *khanapuri* and made over to the cultivators, in whose possession they remained for a month or more, in order that they might thoroughly understand at the time of attestation what rights had been recorded in their names. This, it was thought, would considerably lighten the work of the attesting officer. One disadvantge in making over the *parchas* to cultivators was that when they were returned to the Survey Office for entry of areas and final completion; the majority were in such a filthy state that at least 75 per cent. had to be re-copied. Hill *amins* were chiefly employed in writing up the *khanapuri;* but they are very unreliable and require careful watching.

363. Soils have been classified under the same heads as last season, *viz.*, irrigated, first class dry, second class dry, and *katil* (unterraced slope). As irrigated land is assessed at a higher rate than others, the villagers attempted to conceal it, as far as possible, by destroying irrigation channels (*guls*), and persistently denied that the land was irrigated. Several instances of this were discovered by the European assistants after the *khanapuri* had been finished, when the villagers commenced repairing the irrigation channels, thereby disclosing the deception.

364. Inspections have been constantly made by the European officers. The independent *partals* and check lines run by them aggregate 525 linear miles, and those by inspectors to 1,049 linear miles. This gives an average of 6·8 linear miles of check lines in every square miles surveyed. In 13 cases the survey proved bad and had to be re-done; otherwise the work was found to be good. Of the *khasra* entries, 8,837 were tested by European assistants and 277,374 by inspectors, giving an average of 30 fields checked per cent.

365. The season's out-turn is mapped on 2,896 sheets on the 32-inch scale. In some cases where the fields are exceptionally small, enlarged drawings of them have been made in the margin of the sheets in order to admit of the field numbers being clearly inserted. An index map on the 4-inch scale showing cultivation, principal roads, streams and village boundaries, has been prepared for each *patti*, and duplicate tracings of the same have been supplied to the Settlement Officer.

366. The following are the records prepared for the Settlement Department: (1) *khasra*, (2) dispute list, (3) *phant* or *khewat*, (4) *jamabandi*, (5) *muntakhib*, (6) *khatauni* slips or *parchas*, (7) *milan khasra*, (8) crop statement, (9) statistical statements in English, (10) tracing in duplicate of the village map (on one the different classes of soils are coloured). Up to the 1st October 1891 the records of only 223 villages out of 1,050 of that season's out-turn had been completed, thus leaving 827 for completion during the present season. These 827 (with the exception of one village, the *khasra* of which was called for by the High Court and has not been returned yet) and the records of 498 villages of the current season's work were completed this year.

367. The failure of the winter crops, resulting in general scarcity throughout the district, necessitated the importation of supplies from the plains. These not only arrived very irregularly, owing to the difficulty experienced in obtaining carriage, but, when delivered, cost considerably more than the supplies which had previously been obtained in the district. This naturally caused discontent, and many of the office hands absconded. Then again the outbreak of cholera in April in the *parganas* under survey created a great scare amongst the field establishment, particularly amongst the hill *amins*, many of whom left their work and decamped to their homes directly it was discovered that any one in the village was ill. Doubts were at first entertained of the possibility of completing the *khanapuri* of several villages which had been surveyed. In the end, however, all but 11 villages, in which cholera prevailed up to the close of the field season were completed. Moreover, the physical difficulties of surveying in such a mountainous country are so great that men from the plains can only be induced to

come after a great deal of persuasion, and the excessive cold experienced during half of the field season does not admit of the men working for more than five hours a day, thus interfering with their daily out-turn and monthly earnings. All these put together rendered last season's work most arduous, and Mr. Freeman deserves great credit for showing so large an out-turn under such adverse circumstances.

368. The officer in charge acknowledges the effectual aid rendered by Pandit Manik Lal Joshi, Deputy Collector, who was deputed by the District Officer to attend to the requirements of the Survey Department. Unfortunately his own district work would not admit of his constantly remaining near the central camp, and consequently communication with him was frequently delayed. At times, therefore, his assistance in enforcing the attendance of *zamindars* could not be as readily obtained as desired.

369. The recess office of the party was inspected by the Deputy Surveyor-General on the 8th and 10th of October 1892, who closely examined the field and office books and maps, testing several of the latter with the independent *partal* lines. He has expressed his satisfaction with all that he saw and with Mr. Freeman's energy in overcoming the numerous difficulties he has had to contend with in prosecuting an unusually intricate and troublesome survey.*

BURDWAN ESTATES, BENGAL.

DETACHMENT.

370. The survey of the estates of the Maharajah of Burdwan was once more resumed in accordance with a decision come to at a conference held in June 1891 between the Deputy Surveyor-General, the Director of Land Records, and the Manager of the estates. It was then decided that if the latter could prove that in consequence of the survey operations he had been able to resume possession of any missing villages, then these operations should be continued under Mr. Shaw. The Manager, Lala Bun Behari Kapur, afterwards reported that the work done was valuable to the Raj, and that he had in consequence of the survey been able to resume possession of some of the missing villages. He added that he had been opposed to the undertaking at first, but he now asked for the extension of the survey to *tauzis* 1, 2, and 3 of the Bankura district. This application was made in October 1891. The *Gazette* of 23rd December 1891 notified the continuation of the survey.

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 4th grade, in charge up to 25th June 1892.
Mr. A. B. Smart, Sub-Assistant Superintendent, 2nd grade, from 20th February 1892, and in charge from 26th June 1892.
Babu Sarat Chunder Sen, Sub-Assistant Superintendent, 3rd grade, from 1st November 1891 up to 1st February 1892.
2 computers.
21 sub-surveyors.

371. The programme comprised—

(1) the cadastral survey of 40,000 acres in Bankura and Burdwan;
(2) the traverse survey of *tauzis* 1, 2, and 3 in Bankura district, the area being about 650 square miles.

372. The recess office of the party closed at Burdwan on 12th December, and the camp office opened at Bishenpur, district Bankura, on 17th December 1891. Field work was begun on 1st January 1892. The work from the commencement of the survey has been of a scattered nature. In 1888-89, the Raj had 177 villages traversed as *khas*: in 1889-90, 434 more villages were surveyed. With the exception of a compact block of villages in the north-west corner of *pargana* Bishenpur and some single villages here and there, the whole of the *pargana* may be said to belong to the Raj.

373. In order to survey *tauzis* 1, 2 and 3, it became necessary to connect the villages comprised in these with the old scattered work done in former

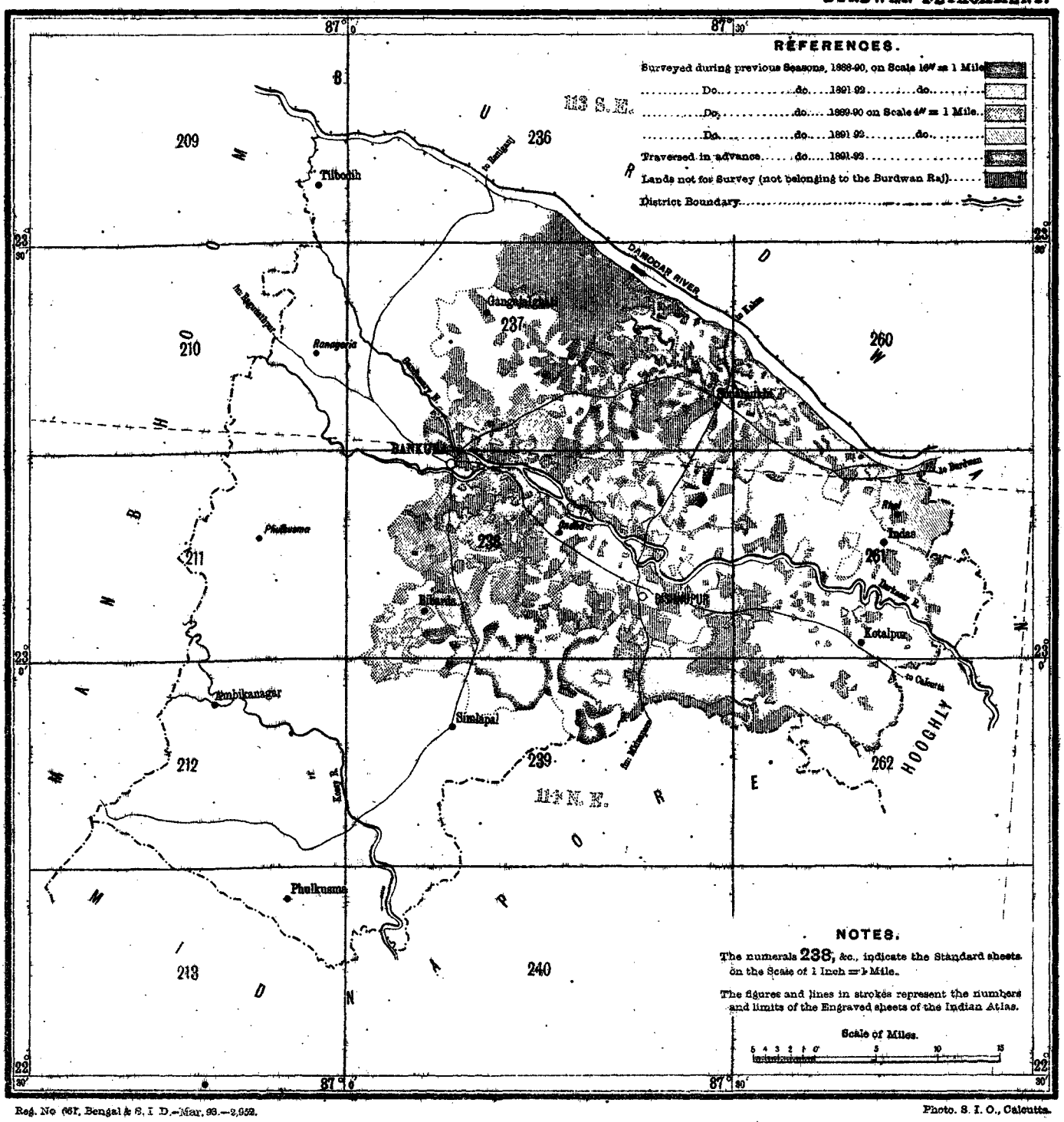
* Mr. Freeman reports well of Messrs. Bedford, Skilling and Murphy, especially of the first, who, he says, is particularly energetic and zealous, and can be relied on to do any work entrusted to him in a satisfactory manner.

Amongst the natives he mentions Budri Parshad, Waris Ali, Hari Singh, Bishambar Sahai, Gunga Parshad and Salamat Ali.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF THE BURDWAN ESTATE IN DIST. BANKURA.

BURDWAN DETACHMENT.



Reg. No 661, Bengal & S. I. D.—Mar. 93.—2,952.

Photo. S. I. O., Calcutta.

seasons, and to incorporate the whole in regular main and sub-traverses, in order to satisfy mathematical requirements, and to render the work fit for future reference.

Tracings of the old revenue survey maps of 1854-55 had to be prepared, and on these tracings had to be coloured all *mauzas* in which the Burdwan Raj had no interest of any sort. The theodolite traverse stations of previous surveys made in 1888—90 had also to be shown on these tracings for the use of the sub-surveyors. This latter operation was very troublesome, inasmuch as the *mauza* boundaries, pointed out during the cadastral survey of 1888—90, did not agree with those shown on the old revenue survey maps.

374. There being no demarcation whatever of the *patni* (permanent tenure) villages, the sub-surveyors were supplied with tracings of the old revenue survey maps, on scale 4 inches=1 mile, with sufficient detail to enable the men to know the boundaries were being followed approximately by the villagers pointing out the lands. Lists of the *patnidars* with their addresses were supplied by the Raj office, but no information was forthcoming showing the particular villages in possession of each *patnidar*. Notices under section 5, Act V of 1875, were served through the post (registered) on the *patnidars* mentioned in the Raj lists, but it was soon found that the names of *patnidars* supplied by the Raj were not correct in many instances. These notices required the *patnidars* to supply the following information :—

(1) *Tauzi* number.
(2) Name of lot.
(3) Name of village.
(4) *Thakbust* number.
(5) Boundaries of villages.
(6) Name and residence of agent properly authorised to point out boundaries and sign maps.

These details, if properly given, would have rendered it possible to discover the *patnidars* in possession of particular lands, and to ensure their attendance to point out boundaries. In very few instances were the *patnidars* either able or willing to give the *thakbust* numbers of the *mauzas* in which their lands are situated. The village names have to be looked out on the revenue survey maps by means of the boundaries supplied by the *patnidars*, and the *thakbust* numbers arrived at in this way. There are altogether 334 *patni* tenures in *tauzi* Nos. 1, 2, and 3. Notices were issued to 313 *patnidars* whose addresses could be ascertained. Of these 313 notices issued, only 132 were returned with the necessary forms filled up, 129 were retained by *patnidars*, but no forms have yet been received, 47 notices were returned twice, and 5 were returned three times. The difficulty of ascertaining the parties responsible for the correct pointing out of the boundaries precluded steps being taken to enforce attendance under the Bengal Survey Act.

375. About the 15th of March, the Manager appointed certain men as *nishandars* to assist the sub-surveyors in procuring attendance of villagers who were acquainted with the *mauza* boundaries, but the assistance rendered by these men was nominal.

376. The *patnidars* were active in their opposition to the survey, traverse station marks and tri-junction stones being removed by them as soon as placed by the surveyors. In several cases the positions of the traverse marks were changed more than once, and it has been difficult when re-surveys have been received to know what discrepancies were due to wrong observations and what to removal of marks. The Magistrate of Bankura was addressed on the subject. Arrangements were in consequence made to have the village *chaukidars* made responsible for the marks, and to grant receipts for them. The police interested themselves for a short while on being stimulated by the Magistrate, and reports from sub-surveyors about removal of marks became less frequent. The full extent to which marks have been removed will only be known when the *amins* go round the boundaries of each village to survey the Raj interests. Owing principally to the uprooting of stations during operations, and of doubtful closings on old work, the re-observations of the angular measurements have been many, 1,500 angles having had to be re-observed out of 18,000.

377. In March 1892, it became apparent that without an increase in the number of sub-surveyors, the traverse work would not be completed by the end of the field season. Six sub-surveyors were transferred from Jalpaiguri to strengthen the detachment.

378. The out-turn of the whole establishment has been very deficient, the average of each man being 22¼ linear miles monthly. The cause of this inadequate out-turn was due not only to the peculiarly difficult nature of the work, but to the fact that new men had to be engaged and taught, no experienced traversers being available.

379. The field office was closed at Bishenpur on the 18th August and re-opened at Motihari on the 24th August 1892. The move to Motihari had been ordered by the Director of Bengal Surveys before he proceeded on leave on the supposition that the survey of the Burdwan Raj would be finished by October 1892. But Mr. Shaw's illness and departure on leave frustrated some ends he had in view with regard to the future of the detachment.

380. The out-turn of traverse work for the season under report is—

District.	Number of villages.	Number of stations of observation.	Linear miles of chaining.	Area in square miles.
Bankura . . .	1,656	17,931	2,706	614
Burdwan . . .	7	175	34	7
Total .	1,663	18,106	2,740	621

The boundaries of the villages and of all the Raj interests within them, almost entirely, remain over for survey.

381. To check the angular work, observations for azimuth were made at 63 stations. Three stations of the Great Trigonometrical Survey were connected with the main traverses; but the comparison between direct distances as obtained from traverse chain measurement and from trigonometrical data has not yet been made, owing to the traverse computations being incomplete.

382. The cost-rate of traversing, including computations, has been R52-8 per square mile.

383. At the end of the recess season only 560 villages out of 1,656 which were traversed had been proved in distances. The great number of re-observations found necessary hindered the progress of office work very much: sub-surveyors were employed on revisions throughout the recess. But the backward state of the work is not due to this cause alone; it is in some measure attributable to Mr. Shaw's departure on leave owing to ill-health.

384. The area to be surveyed cadastrally during the year was estimated by the Manager at 40,000 acres, but this area proved greatly in excess of what the Raj officials were able to point out.

385. Lot Chaitanganj of *tauzi* No. 1, district Bankura, was first taken in hand. The list as supplied from the manager's office gave only the names of the villages. The positions of the villages were discovered from the old maps, and *amins* were sent to survey on the best information they could procure locally. The work dragged on slowly owing to the Raj not being in possession of the lands, and consequently unable to point out their claims. By the 31st of March only 24 small wooden pegs had been placed on the boundaries of a 100-*bigha* plot in the town of Bishenpur. This represented the whole of the demarcation effected by Raj officials, and the officer in charge of the detachment was dependent on this portion of lot Chaitanganj being demarcated by the management, as there were no maps by which surveyors could be guided in distinguishing the Raj lands in the town of Bishenpur.

386. Of the situation of the lands to be surveyed cadastrally in district Burdwan, no information could be obtained from the Manager's office till very late in the season, when a general statement as to the whereabouts of the lots was furnished to the Survey Office. A sub-surveyor was in consequence sent to

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT MANDLA.

No. 9 PARTY.

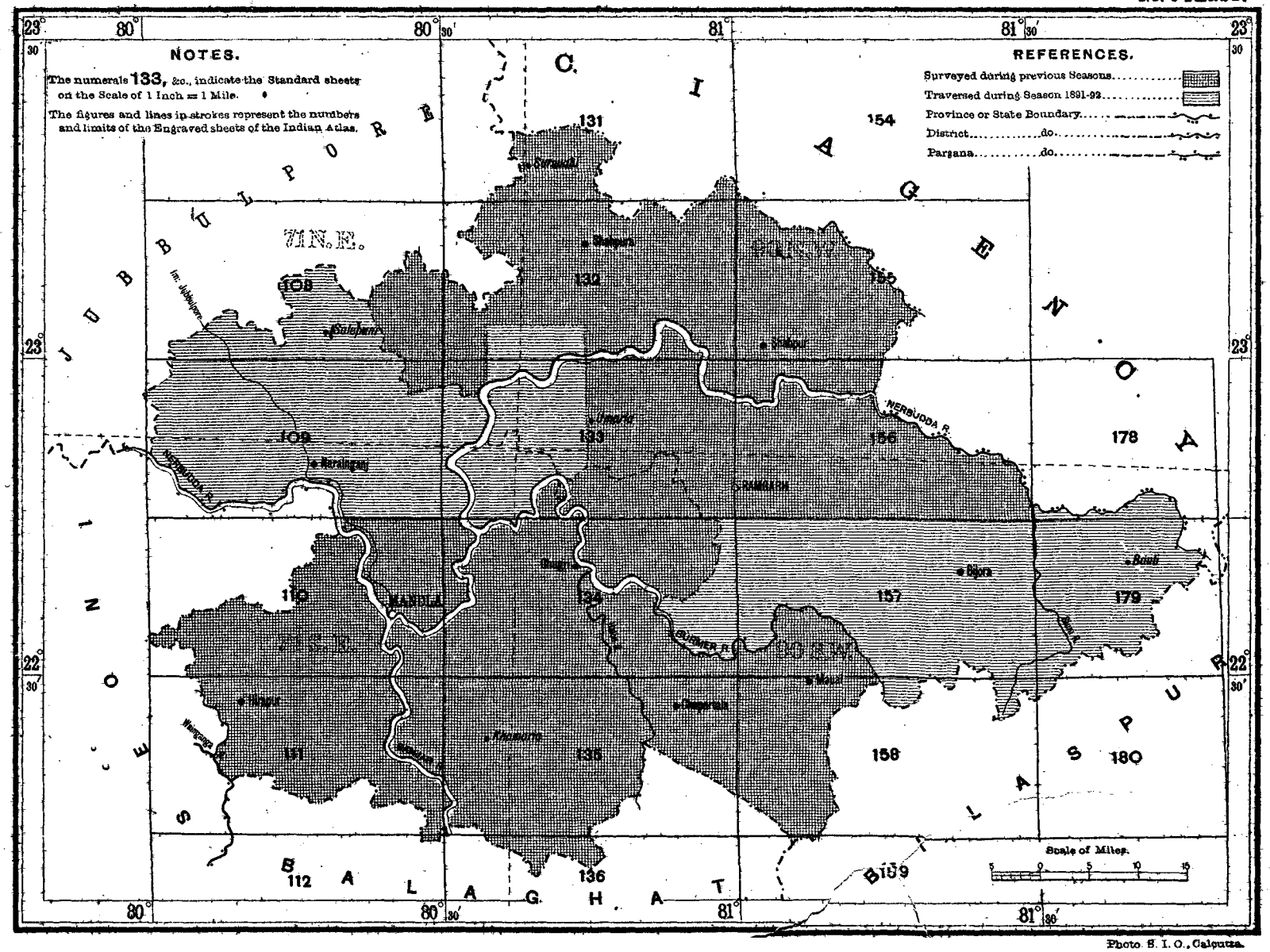
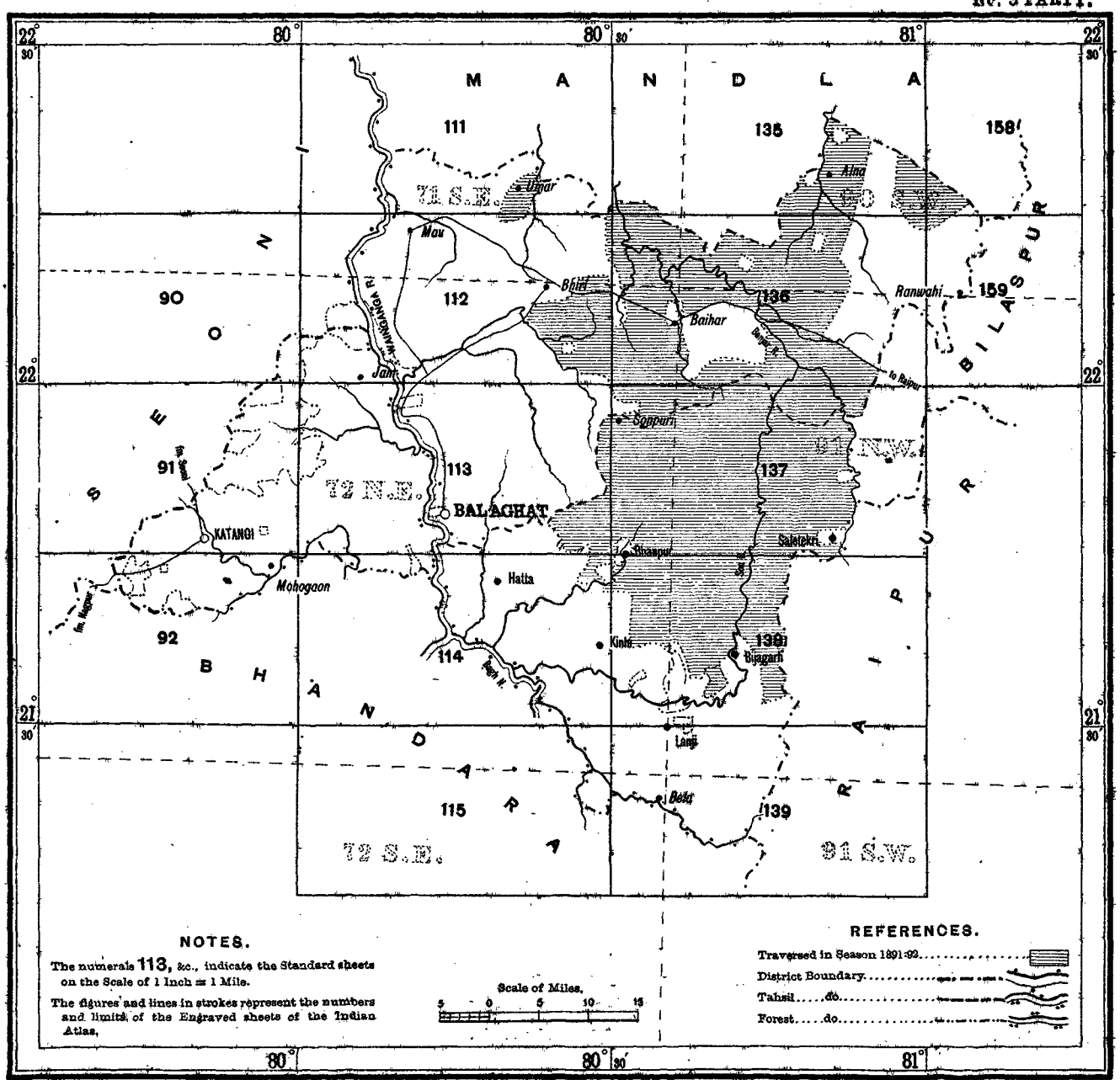


Photo S. I. O., Calcutta.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BALAGHAT.

No. 9 PARTY.



NOTES.

The numerals **113**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

5 0 5 10 15

REFERENCES.

Traversed in Season 1891-92.....

District Boundary.....

Tahsil.....do.....

Forest.....do.....

Reg. No. 425, S. I. D.—Mar. 93.—550.

Photo. S. I. O., Calcutta.

the Manager's office with a request that the lands to be measured should be pointed out to him in detail.

387. Of the seven villages traversed in Burdwan, only three were measured field by field. The out-turn of cadastral work is as follows:—

District.	Number of villages.	Number of fields.	Area in square miles.	Average size of fields.
Bankura	44	40,347	11·29	0·18
Burdwan	3	5,656	2·00	0·22
TOTAL .	47	46,003	13·29	...

388. In order to ascertain the Raj interest in the different *mauzas*, it was necessary to obtain copies of all the *thakbust* maps and statements of *mauzas* in which the estate had any interest. The maps and statements of 1,970 *mauzas* were copied, and efforts will be made during the coming season to discover all missing villages.

389. The total cost of operations for the year was ₹45,954. The cost-rate of cadastral survey and records was ₹281-12-10 per square mile.

390. The area remaining for survey comprises 150 square miles of traversing and 650 square miles of skeleton boundary survey on the 4-inch scale in district Bankura, which will be taken up in the ensuing season.

TRAVERSE SURVEYS,

MANDLA, BALAGHAT AND BHANDARA DISTRICTS,

CENTRAL PROVINCES.

No. 9 Party.

391. This party resumed its traverse operations in the Central Provinces. It was divided into three sections, one for each of the three districts Mandla, Balaghát and Bhandára: the Mandla section continued the traverse work which had been commenced last year, whilst the other two took up the traverse surveys of the *zamindári* and *rayatwári* villages which had been omitted from survey when the Balaghát and Bhandára districts were traversed in previous years. The detachments left recess quarters at Jubbulpore on the 15th November 1891 and closed the field work on the 15th May 1892, when the party proceeded to Kamptee for recess.

Personnel.

Mr. G. H. Cooke, Officiating Superintendent, 2nd grade, in charge up to 15th May 1892.
„ H. Dowman, Extra Assistant Superintendent, 2nd grade, in charge from 16th May 1892.
„ A. George, Sub-Assistant Superintendent, 1st grade.
„ C. H. G. Johnson, Sub-Assistant Superintendent, 2nd grade.
„ G. Rae, Sub-Assistant Superintendent, 3rd grade.
40 surveyors, sub-surveyors and others.

392. Mr. Cooke held charge of the party throughout the whole of the field season, and when he proceeded on furlough on the 22nd May 1892, Mr. H. Dowman was put temporarily in charge, there being no officer of the senior division available at the time.

393. As in previous seasons, the object of the traverse surveys has been to furnish the Settlement Department with a large number of correctly fixed points on which to base the surveys of the fields which are made by *patwáris*. The village traverses closely follow the village boundaries, whilst the sub-traverses, which are about 30 chains apart, divide up the village areas into convenient sized blocks, so that the *patwáris* never have to measure any great distance without finding a fixed point to check their work on.

394. The traverse survey of districts Mandla and Bhandára has been completed, but an area of about 500 square miles remains for survey in district

Balaghát. The following tabular statement shows in detail the out-turn of the season, which is considerably in excess of that of the previous year:—

Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Mandla	876	1,535	29,465	2,174
Bhandára	418	782	14,015	922
Balaghát	399	602	17,140	1,215
Total .	1,693	2,919	60,620	4,311

395. Of the total number of traverse stations fixed, 51,442 have been marked by dressed stones about 2 feet in length, at a cost of 3 annas 1 pie each, or R2-5-2 per square mile. As no district or other complete maps showing boundaries existed, skeleton maps of all the villages on the 2-inch scale have been plotted, and the permanently marked stations conspicuously noted. Tracings of these will be supplied to the village headmen (*malguzárs*) as guides to the relative position of marks, for the preservation of which they are responsible.

396. The demarcation in districts Mandla and Bhandára was good, and was kept well in advance of the survey. In Balaghát, however, it had not been commenced when the party took the field, and the surveyors had no alternative but to survey in advance of the demarcation. The result of this was that many of the boundaries of the *rayatwári* villages, as taken up by the surveyors, were not approved of by the Settlement Department when the authoritative demarcation was made, as it was found that a proportion of forest land, which by the conditions of tenure should have been conceded to the cultivator, had not been included in the areas traversed by the surveyors. This necessitated re-surveys of the boundaries and great alterations in the computations, and threw a great deal of extra work on the party.

397. The country traversed this season was for the most part hilly and densely wooded, the cultivation being scattered and difficult of approach on account of the intervening stretches of hills and forests. Traverse surveying in such a country can only be carried on with difficulty, and, notwithstanding every precaution, it was found necessary to revise a large number of the village circuits. An attempt will be made next year to utilise the bar-subtense method for the lines running up and down the hills. The climate is malarious from October to the end of February, and the party suffered considerably. The principal sickness was influenza, which prevailed throughout all the districts under survey. No less than twenty seven men belonging to the party died of it, one being a sub-surveyor.

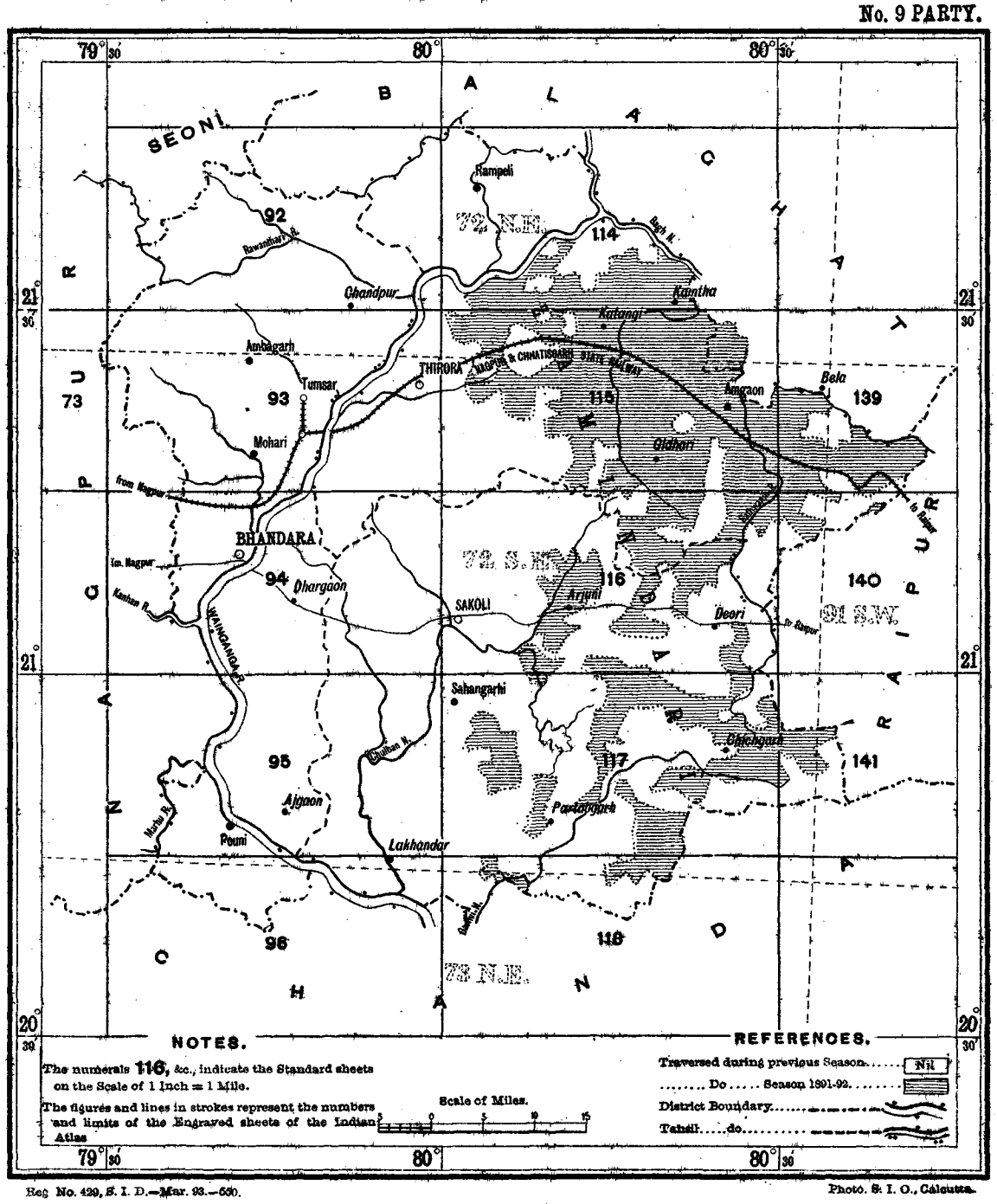
398. Skeleton plots on the 16-inch scale, together with area statements, of 1,171 villages, have been prepared on 2,224 sheets and transmitted to the Settlement Department. The remainder, with traverse data, will follow by the end of November. A skeleton index map of the Mandla district, on the $\frac{1}{2}$-inch scale, is also being prepared for the Settlement Department: this will be the first map showing boundaries that has been prepared.

399. The retention of the party for another year in the Central Provinces having been sanctioned by the Government of India for the survey of the *zamindari* estates situated in districts Raipur, Bilaspur and Sambalpur, covering an area of 1,600, 1,400, and 1,000 square miles respectively, the party will continue to work in the Central Provinces during season 1892-93, and will be again divided into three sections; one section will resume work in Balaghát, as well as commence that in district Bilaspur, whilst to the other two sections will be allotted Raipur and Sambalpur districts. The completion of the whole area, *viz.*, about 4,500 square miles, cannot be guaranteed, as the country presents great physical difficulties, besides being divided into 2,065 villages, which are said to be much scattered, necessitating many extra sub-circuits to connect the work.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BHANDARA.

No. 9 PARTY.



NOTES.

The numerals **116**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas

Scale of Miles.

5 0 5 10 15

REFERENCES.

Traversed during previous Season..... Nil

..... Do ..... Season 1891-92. .....

District Boundary.....

Tahsil.....do.....

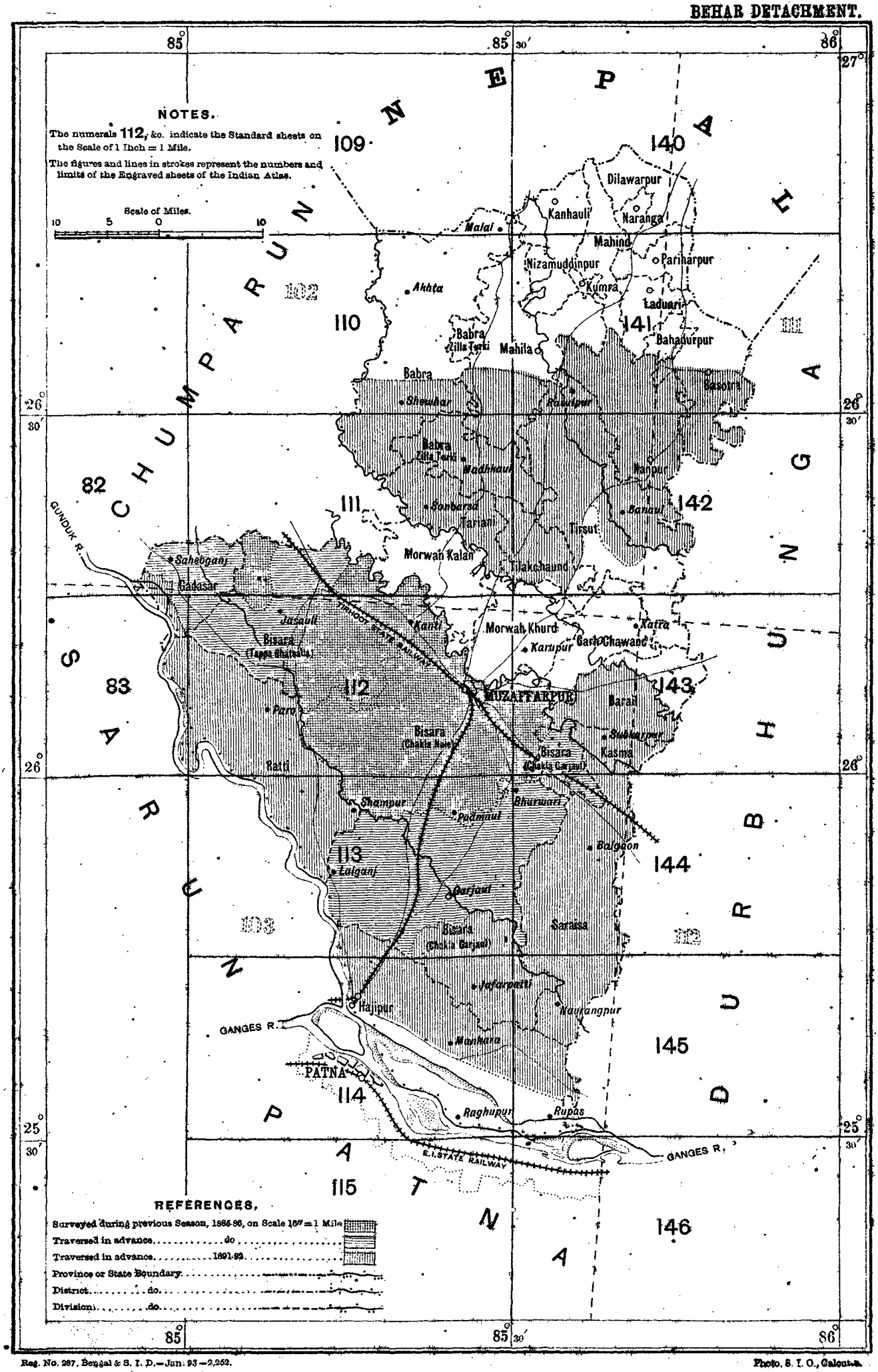
Reg No. 429, S. I. D.—Mar. 93.—550.

Photo. S. I. O., Calcutta.

BEHAR SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT MUZAFFARPUR.

BEHAR DETACHMENT.



Reg. No. 287, Bengal & S. I. D.—Jan. 93—2,252.

Photo. S. I. O., Calcutta.

400. The Deputy Surveyor-General inspected the recess office of the party at Kamptee on the 29th and 30th June 1892, and expressed himself well satisfied with the state in which he found the records of the party. *

MUZAFFARPUR AND CHAMPARAN DISTRICTS, BIHAR.

DETACHMENT.

401. The Government of India, subject to the Secretary of State's approval, sanctioned the survey and the preparation of a record of rights in North Bihar in their letter No. 2135—112, dated 18th September 1891. The notification in the *Gazette* ordering the survey under section 3 of the Bengal Survey Act, V (B.C.) of 1875, of the districts of Muzaffarpur, Darbhanga, Saran, and Champaran is dated 17th November 1891.

Personnel.

Mr. J. S. Pemberton, Officiating Assistant Superintendent, 1st grade, in charge.
„ W. H. D. Ewing, Sub-Assistant Superintendent, 1st grade, from 25th December 1891.
„ H. B. Hanby, Sub-Assistant Superintendent, 3rd grade, from 1st December 1891.
20 sub-surveyors and others.

Temporary Establishment.

13 sub-surveyors and others.
5 *muharrirs.*

402. At the close of season 1890-91, the party known as the Indus Riverain Detachment, having completed its work in the Punjab, was transferred to Bihar and formed the nucleus of the new party, the original strength of which was gradually augmented, by transfers from other parties and fresh appointments, to the strength shown in the margin. The operations were to be restricted during the year under report to the preliminary traverses, the commencement of the cadastral survey being deferred till October 1892.

403. The field of operations was the district of Muzaffarpur, where traverse and cadastral surveys had been commenced experimentally by the late Colonel Barron, Deputy Superintendent, in co-operation with Mr. Collin, Settlement Officer, in 1885-86, but which were discontinued after one season. Before the close of the season the current operations were subsequently extended to Champaran.

404. The detachment assembled first at Patna on the 10th November, pending final orders, which were issued on the 17th idem, the date of the Government of Bengal notification authorising the survey, when all hands moved to Muzaffarpur, where they arrived on the 20th November 1891. A further unavoidable delay was occasioned here, for the notices on landholders and others, required by the Survey Act, V (B.C.) of 1875, had to be printed and issued. Thus it was not till about the 19th of December that actual field work was started, and then only by a small section of the detachment, the entire strength of which was not fully employed till about the 10th January 1892. From this date field work was carried on without any serious interruption until the 17th June, when the field season was practically brought to a close and the party retired to recess quarters at Muzaffarpur, having accomplished during the 5½ months 1,610 square miles, only 90 square miles short of the estimated programme—a result which may be considered satisfactory in view of the late start and other drawbacks, which will presently be noticed.

405. Referring to Colonel Barron's survey of 1885-86, the total area traversed by him aggregates 803 square miles, of which 414 square miles were cadastrally surveyed, leaving a balance of 389 square miles of traverse work, which, added to what has now been done, gives an area of all but 2,000 square miles of traverse survey in advance for next season. In the area previously traversed, the village tri-junction points in 301 square miles were found marked by stones, and this portion was first taken in hand during the season, comprising the whole of *pargana* Ratti, a portion of *pargana* Gadehsar, and a portion of Chakla Gurjaul, *pargana* Bisara.

* Mr. Dowman, who has superintended the party during the recess, has performed his duties well and satisfactorily. He reports very favourably of Messrs. A. George, C. H. G. Johnson and G. Rae, and highly commends Lall Mohun Gungopadhya and Tara Prosunno Roy; he also speaks well of Narsoo, Dinkar, Upendra Nath Mookerjee, Manohar Daji, Kesho Vaijnath, Gopal Sitaram, Keshave Luxmon, Rajaram, Atmaram, Karim Buksh, Wali Mahomed, Gunpat Rai, Murli Manohar, Mayadhari, Murad Ali, Atta Ulla, Issur Singh and Hamid Hossein.

406. The details of the season's out-turn of traverse work are given in the following table:—

District.	Number of villages.	Number of traverse stations.	Linear miles of traverses.	Area in square miles.
Muzaffarpur	2,144	24,537	5,215	1,247
Champaran	238	5,302		363
TOTAL	2,382	29,839	5,215	1,610

407. In *pargana* Hajipur of the Muzaffarpur district, the portion of country bordering the Ganges and Gandak rivers, known as the *diara*, which is subject to fluvial action and embraces an area of about 100 square miles, has been omitted from the present season's operations, and will have to be traversed in the same season that the cadastral survey is undertaken, the reason for the omission being the great probability of the stations being washed away during the floods if put down this season. Likewise the *diara* lands along the Gandak, area about 137 square miles, have also been omitted in the Champaran district.

408. The temporary demarcation of village boundaries was carried out by the *zamindars* simultaneously with the traversing, because no tract of country had been previously prepared for survey. The demarcation pillars are merely earthen mounds from 2 to 3 feet high, well rammed down round a bamboo peg firmly fixed in the ground and plastered over. The demarcation not having been done in advance has been a source of delay throughout the season.

409. Every surveyor was furnished with tracings of the village boundaries from the old 4-inch revenue survey of 1843—47 to enable him to make a rough comparison with the boundary pointed out. Except in a few instances, where new *mauzas* had been formed or boundaries had been altered for other reasons since the old survey, the general run of the boundaries was found to agree well.

410. The angular measurements have been checked by observations for azimuth at 153 stations, and the average error thereof amounts to 1 minute in every 21 angles. The linear measurements were checked by connections with stations of the Great Trigonometrical Survey, and the average error of the chaining was found to be 3 feet per mile.

411. The area remaining for traverse survey in the Muzaffarpur district amounts to—

	Square miles.
Muzaffarpur sub-division	430
Sitamarhi ditto	484
TOTAL	914

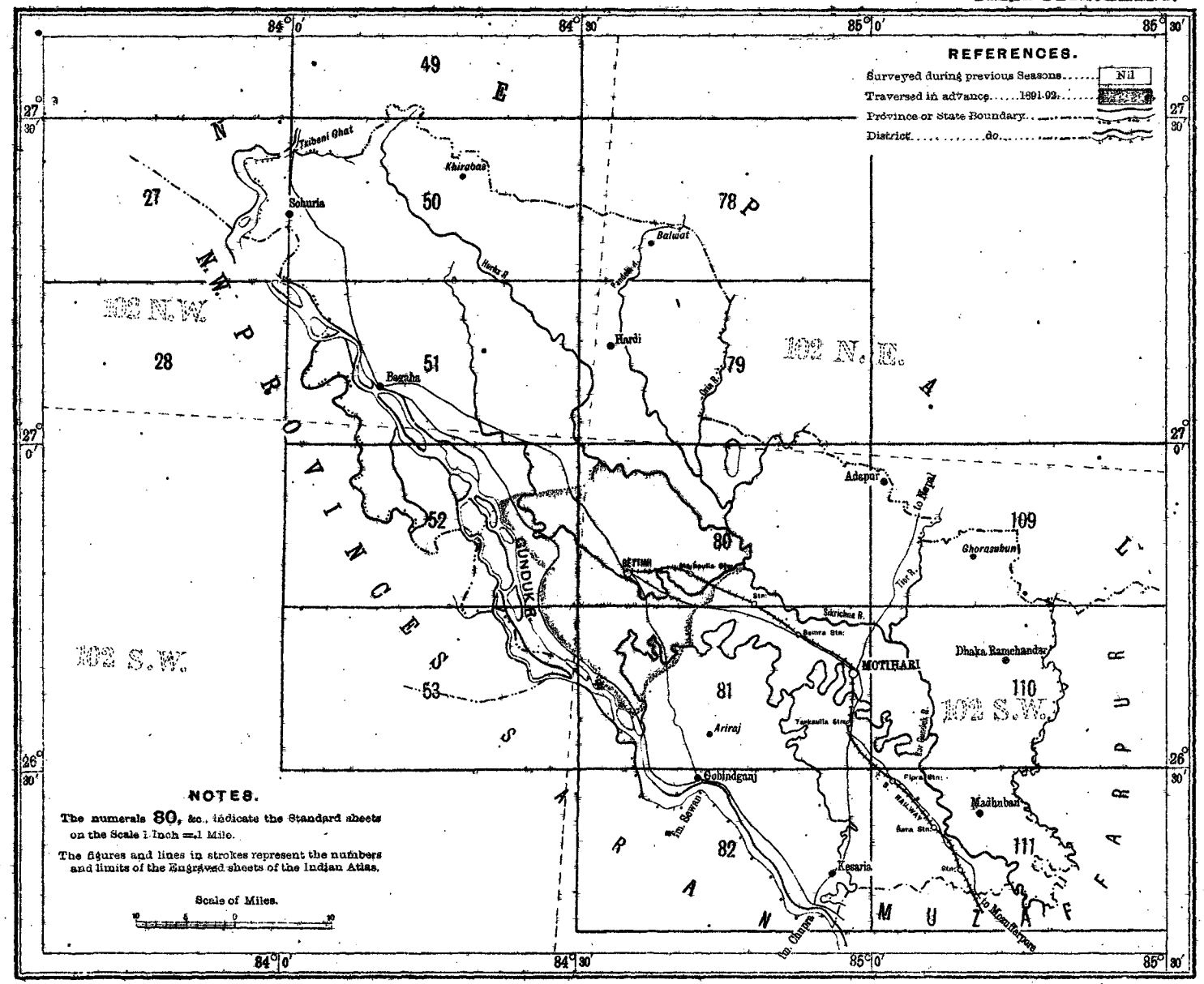
412. The attitude of the inhabitants in Muzaffarpur was one of passive obstruction throughout, principally shown in dilatoriness in attending when called on to point out their boundaries and in disputing for hours over boundaries that had never been questioned before, thus causing serious loss of time: these were not exceptional cases, but said to be the experience of almost every surveyor in the field. These statements are not absolutely reliable.

In the Bettiah estate there was no such obstruction, indeed no checks or hindrances of any kind whatever, due to the influence and good management of Mr. T. M. Gibbon, C.I.E., the Manager of the estate, to whom the officer in charge of the detachment expresses himself as much indebted.

413. One difficulty experienced in the survey was to get landholders generally to understand the distinction between a traverse station and a boundary mark. Nothing would convince them that they were not necessarily one and the same. Hence if any peculiarity in the nature of the country compelled the surveyor to put down a mark anywhere but actually on the boundary, a cry of injustice was immediately raised and petitions were submitted to have the marks removed, notwithstanding repeated assurances that the position of traverse stations in no way affected actual possession or prejudiced the rights of any

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. CHAMPARAN. BIHAR DETACHMENT.



Reg. No. 23, Bengal & S. I. D.—Mar. 93.—2,953.

Photo. S. I. O., Calcutta.

one. If their wishes were not acceded to, they not infrequently refused to allow the survey to proceed. It was not till several fines were inflicted that this difficulty was, to some extent at least, removed. The fines inflicted on *zamindars* were 14 in number, and were for cases of non-attendance and for uprooting and otherwise destroying survey marks, actionable under sections 51, 52, and 53 of Survey Act, V of 1875.

414. The stones used for marking village tri-junctions and certain other intermediate traverse stations were all of one pattern, *viz.*, blocks of sandstone, 2 feet long, rough hewn to 4½ inches from the end, which was cut into a triangular prism of 5-inch sides. In accordance with arrangements made with the Bengal Stone Company, Mirzapur, 22,000 of these stones have been supplied at the rate of 8 annas per stone landed at Muzaffarpur. Of this number, 10,758 have been used in the present season's work, both in the Muzaffarpur and the Champaran districts, giving an average of six stones per square mile of country. The balance, 11,241, have been stored in the office compound at Muzaffarpur. In April, the Director arranged with Messrs. Burn & Co. at Raniganj to supply 11,000 marks of pottery, 10,000 of which are glazed pipes 2 feet long of 2-inch diameter for ordinary traverse stations, costing 2 annas each, and 1,000 for tri-junction points, being cylindrical cones, measuring 2½ feet long of 8-inch diameter, at 12 annas each: these arrived too late to be made use of, and have been stored in the circuit-house compound at Motihari. It is expected that these special marks when filled with clay will answer the same purpose as stones, and being lighter there will be considerable savings in the charges for carriage.

415. The health of the establishment throughout the season was on the whole good. During the months of May and June cholera in an epidemic form prevailed throughout the country, most virulently to the east of the Muzaffarpur sub-division and south of the Sitamarhi sub-division, where work had for a time to be suspended. In the low-lying lands bordering "Tal Barela," the largest *jhil* in the Muzaffarpur district and situated in *pargana* Saraisa, malarial fever is more or less always prevalent, but especially during April and May, the time unfortunately when the men were employed in the neighbourhood, and consequently they suffered a good deal. Only three deaths in the establishment occurred during the season, two from cholera and one from snake-bite.

416. The cost-rates, deduced from the total expenditure incurred from the time the party was transferred from the Punjab, including the extraordinary expenses of transit therefrom, are as follows:—

	Per square mile. R a. p.
Stone embedding	10 6 5
Traversing	24 4 9
Total for traverse survey .	34 11 2

417. During the recess, the traverse computations and skeleton plots, on the 16-inch scale, have been completed of the entire season's work. Also rough skeleton plots have been prepared on the 4 inch scale, comprising congregated villages limited by sub-circuits to serve as indices to the cadastral records for survey and settlement, and to permit of a comparison being made on the same scale with the old revenue survey maps. This is necessary to satisfy the requirements of the Tenancy Act, which limits the hereditary rights of tenants to the "village of the revenue survey."

418. During the recess season training schools were organised at Muzaffarpur and Motihari, and *zamindars* and planters were invited to send in *patwaris* or their relations for instruction. At first, men came forward reluctantly in Muzaffarpur, but matters improved towards the end of June. At the Muzaffarpur school, 279 men were put through a course of instruction and 80 more were under training at the beginning of October. At Motihari, 180 men were trained for work in the Champaran district.

419. Mr. Pemberton deserves credit for his efficient conduct of the operations.

420. This detachment has now been merged into No. 4 Party, which, on completion of its work in the Western Duars, has been transferred to Bihar to carry out the cadastral survey, and the combined establishments will carry out

the following programme in the ensuing season, *viz.*, the traverse survey of 914 square miles in district Muzaffarpur and 2,000 square miles in districts Champaran and Saran, and the cadastral survey on the 16-inch scale, with the record of rights, of 1,000 square miles in districts Muzaffarpur and Champaran.*

GEODETIC.

LONGITUDE OPERATIONS.

NOS. 22 AND 23 PARTIES.

421. The services of two officers being available for astronomical work during the season under review, the operations for the electro-telegraphic determination of arcs of longitude were resumed. Those selected for measurement form part of the general scheme for extending a net-work of longitudinal arcs over the whole of India, and comprised the following arcs:—

Personnel.

No. 22 PARTY.

Captain S. G. Burrard, R. E., Deputy Superintendent, 2nd grade, in charge.
Aulad Hussein, Sub-Assistant Superintendent, 3rd grade.
Gobind Balwant Joshi, computer.

No. 23 PARTY.

Lieutenant G. P. Lenox-Conyngham, R. E., Assistant Superintendent, 1st grade, in charge.
Lal Singh and Hanuman Persad, computers.

1. Calcutta-Waltair.
2. Waltair-Jubbulpore.
3. Waltair-Bolarum.
4. Waltair-Madras.
5. Bolarum-Bombay.
6. Fyzabad-Dehra.

422. The programme was carried out in its entirety, and there is no special novelty to be noticed in the observations that were made. The apparatus has been now in use for so many years that the best methods of using it had become quite familiar to the observers, and no departure from the fixed procedure was deemed advisable. Constant vigilance to guard against the intrusion of minute errors is imperative, and due caution in this respect has been exercised. On the Waltair-Jubbulpore arc, owing to the faulty insulation along the coast and the great length of the telegraph line, which ran *viâ* Ranigunge and was nearly 1,100 miles long, no signals could be passed *directly*, and a translating station had consequently to be introduced at Cuttack. Translating stations have always been carefully avoided hitherto, for fear that they might affect the retardation of the current, and this is the first occasion in the history of Indian longitudes that direct communication has been unattainable. The introduction of a translating station on the Waltair-Jubbulpore arc has been found to almost double the time of retardation of the current, but there is no reason to suppose that the accuracy of the results is in any way vitiated thereby.

423. Great difficulty was experienced in former years in obtaining distinct reflection of the spider lines in the mercury trough at Calcutta owing to the extremely unstable nature of the soil ; a tremor sufficient to obliterate the reflected image of the wires would be set up on the surface of the mercury by the wheels of a passing carriage long before even the sound of the carriage could be heard, and a cough or sneeze would often render the image invisible for five or six seconds. This season the difficulty was overcome by the following expedient : a circular trough of copper, formed like a very shallow saucer, was prepared and its surface was amalgamed with mercury by means of sulphuric acid rubbed over it ; the effect of the *amalgam* was that the surface of the copper became "wetted," and vibrations of the ground were not communicated to the mercury. It was used with complete success, as distinct reflections were obtained when vehicles were passing within 100 yards, and when no reflection whatever was visible in the ordinary mercurial trough.

424. In several previous reports the existence of errors larger than seemed consistent with the great care expended on the work has been noticed.

* Mr. Pemberton reports as follows :—

"Mr. W. H. D. Ewing, Sub-Assistant Superintendent, has laboured zealously. Mr. H. B. Hanby, Sub-Assistant Superintendent, only joined the Department on the 25th November 1891. He has given close application and attention to his duties.

Of the native establishment the most deserving of commendation are Elahi Bux, English writer, Awaz Ali, Abdul Aziz I, Ramjas, Mauladad Khan, Gorumph Singh and Ram Lachun Lal."

In season 1889-90 it was unexpectedly discovered that the value of the collimation constant varied with the angle at which the collimators were inclined to the horizon during the process of determination. This discovery led to the introduction of a new method of deducing the collimation constant. During the recess, the re-computation of all former arcs has been carried out on this new method, and all the abnormally large circuit errors, which had attracted so much attention in the past, have been found to disappear. A detailed account of some experiments connected with this subject will be found in Captain Burrard's narrative report in the appendix. The result of these experiments was that the two collimators of each equipment were found to possess more or less imperfect object glasses; the object glass of telescope No. 2 was also proved to be by no means perfectly true, but no faultiness was discovered in that of telescope No. 1.

425. It fortunately happens that the two transit instruments were admirably designed and made, and that throughout their long career of seventeen years (with the exception of two seasons) they have exhibited no signs of weakness or unsteadiness. If they had been of inferior make, and if *real* variations in the collimation constant had been of frequent occurrence, as was at one time suspected, no remedy now would be forthcoming to correct the effects of the faultiness of the object glasses. If the telescope is shaky and the collimation constant unsteady, the old method of determination is necessary, though it has been shown to be incorrect if the object glasses are faulty. The new method of determining the collimation constant eradicates the evil effects arising from faulty object glasses, but is not applicable to a shaky telescope.

426. In speaking of the faultiness of object glasses, it must not be supposed that any want of care is to be attributed to the makers. The manufacture of object glasses is one of the most difficult known; very few turn out to be perfect in form and refractive properties, and a certain amount of chance is involved in the process. It is possible, though not very likely, that these object glasses may have deteriorated with age.

427. Extracts from the narrative reports of Captain Burrard and Lieutenant Lenox-Conyngham on the season's operations will be found in the appendix.

428. The scheme of longitude work in India proper having been now completed as far as at present contemplated, the simultaneous reduction of the whole network has been taken in hand, and computed during the current year, with very satisfactory results, which rank in point of accuracy with the best continental and American work.

429. Captain Burrard and Lieutenant Lenox-Conyngham both acknowledge the courtesy of Messrs. Chambers and Michie Smith, the astronomers in charge of the Bombay and Madras Observatories, and of the various Telegraph officials with whom their duties brought them in contact.

430. The parties during recess worked in the office of the Deputy Surveyor-General, Trigonometrical Branch, who reports very favourably on their efficiency during the year.*

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

431. The charge of these operations has remained in the hands of Lieutenant-Colonel J. Hill, R.E., throughout the year. His staff has been strengthened by the addition to it of an Assistant Superintendent. Lieutenant C. C. D. Morice, R.E., joined the party in that capacity

Personnel.

Lieutenant-Colonel J. Hill, R.E., Superintendent, 2nd grade, in charge.
Lieutenant C. C. D. Morice, R.E., Assistant Superintendent, 2nd grade, from 11th November 1891.
Mr. G. Belcham, Extra Assistant Superintendent, 2nd grade.
„ E. J. Connor „ „ „ 3rd „
„ J. Bond „ „ „ 3rd „

Surveyors, etc.

Narsing Das, Dhondu Venayak, Venayak Narayan, 2 native mechanics, and 17 recorders and computers.

*Captain Burrard and Lieutenant Lenox-Conyngham report favourably of the work performed by their assistants. In No. 23 Party, Babu Hanuman Persad is stated to have proved himself an exper recorder.

on the 11th November, and Colonel Hill in his reports mentions him in very high terms.

TIDAL OPERATIONS.

432. The automatic recording of the tidal curves, their reduction, and the publication of the predicted times and heights of high and low water, have been continued, and tidal observations, by means of self-registering gauges, have been carried on during the year at fourteen stations, *viz.*, *Aden*, *Kurrachee*, Bhávnagar, *Apollo Bandar* (*Bombay*), Prince's Dock (Bombay), Cochin, Minicoy, Tuticorin, Trincomalee, *Kidderpore*, Akyab, *Rangoon*, Mergui and *Port Blair*. The eight tidal stations whose names are not italicised are minor stations, where observations, as a rule, are taken for five years only. The others are permanent stations, where the minimum period of observations lasts for nineteen years, and where observations should be continued until the whole scheme of tidal operations has been completed. In addition to the automatic observations taken at the stations enumerated above, personal tidal observations to graduated staves were taken daily with the object of comparing the actual heights and times of high and low water with those predicted in the Tide Tables. This was done at the following tidal stations, at all of which the tidal observatories are closed, *viz.*, Cochin, Cocanada, Chittagong, Akyab, and Moulmein.

433. During the season under report no tidal observatory has been newly established, and two have been closed. The Cochin tidal observatory, after having been at work for six years, was closed on the 20th March, an extra year's observations being taken at this station in consequence of the interruption to the registrations mentioned at page XXXII of the appendix to the General Report for 1886-87. The Akyab tidal observatory was closed on the 23rd May on the completion of five years' observations.

434. Thus, since the resumption of systematic tidal operations in 1877, observations have been taken at 31 tidal observatories, of which 19 (including Madras) have been closed on the completion of their registrations and 12 are now in operation.

435. The Port Blair tidal observatory was destroyed during the cyclone of the 1st November, and details of the disaster are given by Colonel Hill in the appendix. The observatory was re-established and the self-registering tidal observations were resumed on the 30th January, and it is due to the prompt and energetic help given by Colonel Cadell, V.C., the Chief Commissioner of the Andamans, and his staff, that the interruption to the registrations did not extend beyond this period of three months.

436. It was reported last year that the commencement of tidal observations at the four following new minor stations had been sanctioned: Diamond Island (Burma), Muscat (Arabia), Bushire (Persia), and the island of Sálbet (Káthiáwár). Since then Port Albert Victor in Bhávnagar has been substituted for Sálbet as being better suited for the purpose; the site chosen is two miles north of the island of Sálbet. Work connected with the erection of the observatories is in progress at Diamond Island, Bushire, and Port Albert Victor. The work at Diamond Island has proved more difficult, tedious, and expensive than was anticipated. At Bushire, the masonry has been finished, under many difficulties, by Mr. R. H. New, to whom our thanks are due for his kind assistance. At Port Albert Victor, Mr. Proctor Sims, the Bhávnagar State Engineer, has been carrying out the masonry and other work of the tidal observatory, which, according to his plans, will be combined with a light-house. At Muscat, where no preliminary masonry construction is contemplated, the preparations are complete. It is expected that tidal observations will be commenced at all four stations during the ensuing field season. Mention must not be omitted of the great assistance received from Mr. W. W. Squire, the Engineer to the Bombay Port Trust, who had the necessary timber observatory houses, float cylinders, and other accessories for Muscat and Bushire made under his personal supervision and forwarded to their destinations, and who, in many other ways, has helped on the tidal work from time to time. It is to be hoped that tidal observations at Madras will be resumed eventually, but no decision on that point has as yet been arrived at by the Madras Government.

437. All the tidal observatories, without exception, have been inspected, and a detailed account of the working of each will be found in the appendix, where also certain circumstances requiring special notice are reported at Kurrachee, Bhávnagar, Prince's Dock, Bombay, Minicoy, Tuticorin, Cocanada, Moulmein, and Port Blair. If the loss of three months' observations at Port Blair, which is a matter of great regret, be excepted, the tidal operations of the year may be pronounced very successful—a result due to a great extent to the assistance received from local officials, whose kind co-operation has been acknowledged by Colonel Hill.

438. The reduction of the tidal observations has been carried on steadily during the year. Observations for one year at fourteen stations have been reduced, and the tabulated values of the tidal constants so obtained will be found in the appendix. In addition to them, constants to be employed in setting the tide predictor were calculated for the year 1893, and sent to Mr. Roberts, of the Nautical Almanac Office, ready for use; he was also furnished with tabulated comparisons for the year 1891 between the predicted times and heights of high and low water at 51 stations, published in the Tide Tables for that year, and their values obtained by actual measurement, thus giving him in a convenient form information adapted to assist him in improving subsequent predictions, especially at the principal riverain ports, Kidderpore, Rangoon, and Moulmein.

439. The Tide Tables for 1893 will contain predictions for 33 tidal stations, the new stations of Minicoy and Trincomalee having been added since the last issue.

440. The usual tables showing the results of the predictions are given, for the year 1891, in the appendix, and may be summarised as follows :—

Percentage of Time predictions within 15 minutes of actuals.

	High water, per cent.	Low water, per cent.
11 Open coast stations	76	75
4 Riverain stations	68	62

Percentage of Height predictions within 8 inches of actuals.

	High water, per cent.	Low water, per cent.
11 Open coast stations	94	87
4 Riverain stations	66	64

Percentage of Height predictions agreeing with actuals within one-tenth of mean range at springs.

	High water, per cent.	Low water, per cent.
11 Open coast stations	97	96
4 Riverain stations	92	88

These figures are very satisfactory, and show a high standard of accuracy in the predictions taken as a whole.

SPIRIT-LEVELLING OPERATIONS.

441. The levelling operations of the last field season consisted of a continuous line of double levelling carried along the Great Indian Peninsula and Bengal-Nagpur Railways, comprising the following sections :—

Section from Malkhed (Great Indian Peninsula Railway) to Nagpur.
Section from Nagpur to Bilaspur.
Section from Bilaspur to Sakti.

The total out-turn-amounted to 452 miles of double-levelling, in the course of which the heights of 529 permanent bench-marks and 12 stations of the Great Trigonometrical Survey have been determined. This is a good and creditable out-turn, which would have afforded unmixed satisfaction had it not been accompanied by the loss of an old and valued member of the Department, Sub-Surveyor Narsing Das, who died in the field on the 5th April, and whose promotion to the junior division was under consideration at the time of his death. Every assistance was given to the levelling detachment by the Railway officials, for which Colonel Hill has expressed his obligations.

442. It is intended to postpone the extension of the levelling beyond Sakti on the Bengal-Nagpur Railway, and to employ the levelling detachment in Burma during next season on a double line of levelling from Rangoon to Mandalay, with branch lines to connect certain stations of the Eastern Frontier and Mandalay series of the Great Trigonometrical Survey.

This line, besides checking the trigonometrical heights, will furnish bench-marks for reference in irrigation and other projects of the Public Works Department, and test bench-marks for the Rangoon and Elephant Point tidal observatories ; the programme also includes a line of double-levelling between Rangoon and Elephant Point.

443. In addition to the regular departmental work of the tidal and levelling party, a considerable amount of extra work had to be undertaken in order to furnish other departments and Local Governments with information applied for by them, the particulars of which are given in the appendix.

444. The office of this party at Poona was inspected by the Officiating Surveyor-General in August 1892, who reports his satisfaction at the efficient state of the party and the out-turn of its work.*

GEOGRAPHICAL SURVEYS.

OPERATIONS IN UPPER BURMA.

No. 11 Party.

445. At the commencement of the year under review, the charge of this party was held by Captain Renny-Tailyour, R.E., but on the return of Captain Jackson, R.E., from furlough on the 4th November 1891, that officer resumed charge and conducted the operations throughout the field season. On return to recess quarters in June 1892, he was invalided by a medical board and granted a year's sick leave, when Captain Renny-Tailyour resumed charge of the party. Colonel Woodthorpe, R.E., on his re-appointment to the Survey Department in July, was posted to the charge of the party, and held it during the remainder of the year. The strength of the party is shown in the margin.

Personnel.

Captain H. M. Jackson, R.E., Deputy Superintendent, 1st grade, in charge from 4th November 1891 up to 11th July 1892.

Captain T. F. B. Renny-Tailyour, R.E., in charge up to the 4th November 1891 and from the 4th June 1892 up to the 11th July 1892.

Colonel R. G. Woodthorpe, C.B., R.E., Officiating Superintendent, 2nd grade, in charge from 11th July 1892.

Mr. F. Kitchen, Extra Assistant Superintendent, 3rd grade.

„ J. Doran, Extra Assistant Superintendent, 4th grade.

„ R. F. Warwick, Sub-Assistant Superintendent, from 1st November 1891 up to 28th May 1892.

Surveyors and Sub-Surveyors.

Mahmud Hosein, Mr. J. Sebastian, Ramsabad, Kudratullah, Abdul Rahim, Mowni Ram, Sita Ram and Nuruddin.

446. The party arrived on the 6th November 1891 at Pyinmana, which was made the headquarters for the field season. The operations were closed in May 1892, and the various members of the party reached Bangalore between the 19th May and 6th June, when the office opened for recess work.

447. The operations were similar in character to those carried on during the previous season, the methods employed being a mixture of plane-tabling, traversing and route-surveying, as circumstances permitted. The work lay in the districts of Pyinmana and Toungoo, the Bret country, Karenni, the Southern Shan States, and the independent State of Baw.

448. Captain Jackson generally supervised the field work of the party, carrying on the triangulation and doing a small portion of the topography. Mr. Kitchen with two surveyors worked in the Shan States east of the Kyaukse district ; Mr. Doran with two surveyors was employed in the Maingkaing State ; and Mr. Warwick and the other surveyors in the other tracts.

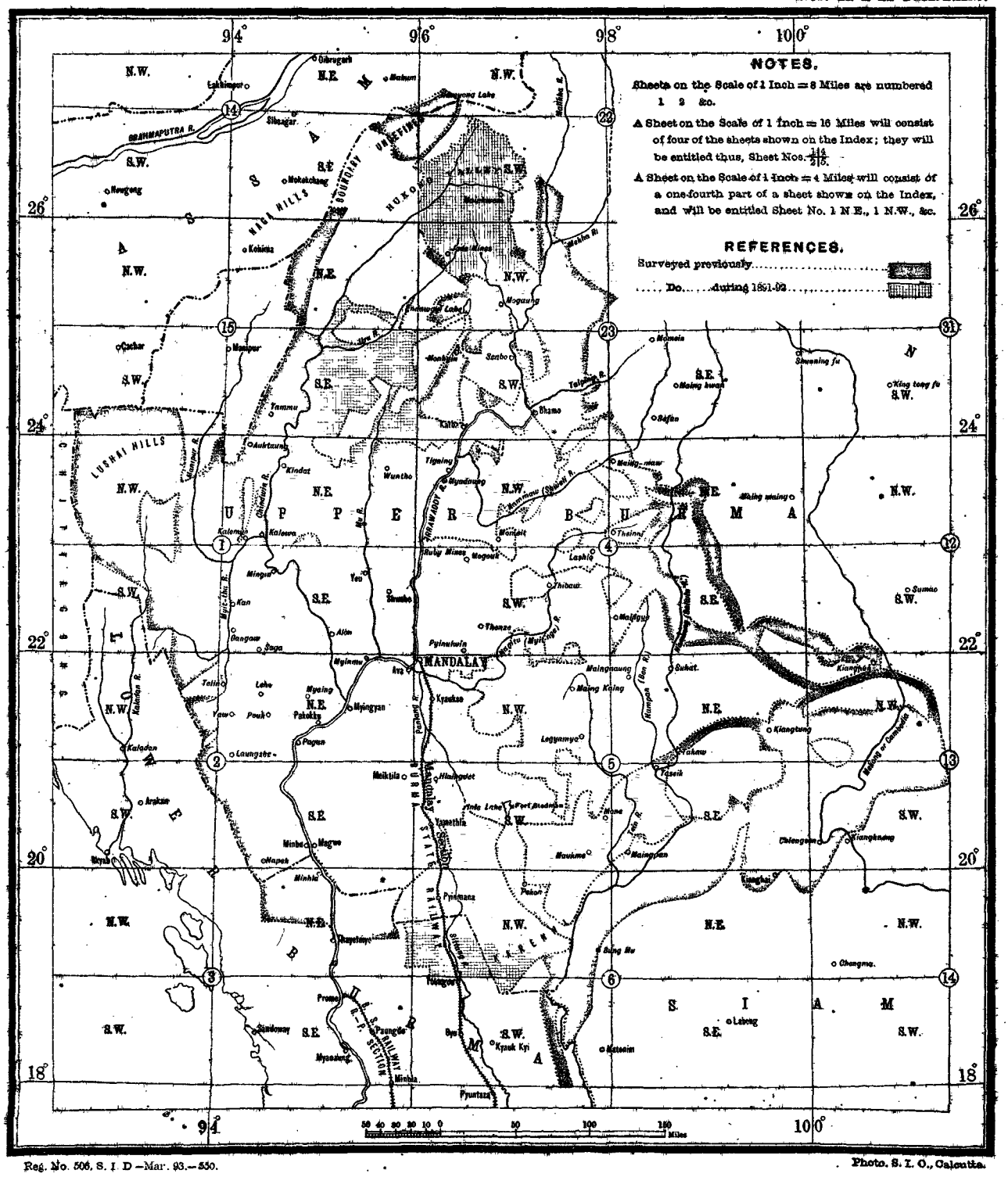
Messrs. Kitchen and Doran did some triangulation in addition to the plane-tabling ; and the work of the rest was confined to topography. A small portion of Karenni is left unfinished owing to the mutiny of the escort with the surveyor there. It is hoped that this gap will be filled in this season.

* Colonel Hill reports most favourably of Messrs. Belcham and Connor and Surveyor Dhondu Venayak in the tidal division, and of Mr. Bond and Sub-Surveyor Narsing Das in the levelling division. Mr. E. Bond and Mr. G. H. Belcham, temporarily attached to the party, are favourably noticed ; and the staff of native mechanics, surveyors, sub-surveyors, and computers are reported to have worked well and given satisfaction.

NORTH EASTERN & SOUTH EASTERN FRONTIER SURVEY.

INDEX TO THE GEOGRAPHICAL SURVEY IN UPPER BURMA.

Nos. 11 & 21 PARTIES.



Reg. No. 506. S. I. D.—Mar. 93.—550.

Photo. S. I. O., Calcutta.

449. The result of the season's operations is as follows :—

Triangulation	6,400	square miles.
Topography on ½-inch scale . . .	18,002	,, ,,

450. The country surveyed is generally of a difficult nature. The forest-clad hills are wild and rugged or low and undulating, and the valleys covered, in many cases, with almost impenetrable grass. In parts, as in the Laihka State, which was once flourishing, fire, sword, and famine have desolated the country, which is quite deserted, and though the people are beginning to return, it will be long before the old order is restored. This desolation renders a surveyor's work very arduous, as the whole of the ground once under cultivation, when neglected, soon becomes covered with high elephant grass.

451. The health of the party was good on the whole, though Mr. Doran's men suffered somewhat on the road to his work. Messrs. Warwick and Sebastian suffered a good deal at times from fever; and Captain Jackson returned, under Captain Renny-Tailyour's care, so ill that he had to be invalided home as soon as he was able to bear the journey.

452. During January, Captain Jackson visited a portion of the "Bret" country, which lies south-west of Karenni in the valley of the Tuchaung. He has submitted a short report on the country traversed and its inhabitants, which will be found in the appendix.

453. The programme for the next field season includes the deputation of surveyors to accompany the Burma-Siam Boundary Demarcation Commission and continuation of work in the Southern Shan States, as far as the means available will permit.

454. The recess office of the party at Bangalore remained, as heretofore, under the same roof as the office of No. 21 Party, an arrangement productive of much convenience to both, as their work is intimately connected and constant references are necessary. Both parties were inspected by the Officiating Surveyor-General in August 1892, who found them in a highly efficient state, and controlled in a manner that reflects credit on the executive officers who have held charge of them.*

No. 21 Party.

455. The party, under the charge of Captain Longe, R.E., left recess quarters for the field on the 24th October 1891 and arrived at Mandalay on the 6th November. Captain Longe retained charge till 21st February 1892, when he was deputed to England to attend a course at the School of Military Engineering, Chatham, and made over charge to Captain Renny-Tailyour, R.E. This officer held it until the 19th July 1892, and was then relieved by Colonel Woodthorpe, who had been recently re-appointed to the Department, and who retained charge during the remainder of the recess season.

Personnel.

Captain F. B. Longe, R.E., Officiating Superintendent, 2nd grade, in charge up to 21st February 1892.
Captain T. F. B. Renny-Tailyour, R.E., Deputy Superintendent, 2nd grade, in charge from 22nd February up to 19th July 1892.
Colonel R. G. Woodthorpe, C.B., R.E., Officiating Superintendent, 1st grade, in charge from 19th July 1892.
Captain P. J. Gordon, S.C., Officiating Deputy Superintendent, 2nd grade.
Mr. W. C. G. Barckley, Sub-Assistant Superintendent, 1st grade.
,, J. M. Kennedy ,, ,, ,,
,, C. George ,, ,, ,,
,, W. F. E. Adams ,, ,, 3rd grade.

Surveyors and Sub-Surveyors.

Sher Shah, Ikbaluddin, Faida Ali, Ali Nawaz Khan, Mahomed Latif, Mahomed Alum, Mahomed Sayed, and Mahomed Nawaz Khan.

456. The operations were of the same character as in former years, *viz.*, geographical surveys and reconnaissances, on the scale of 1-inch = 4 miles, north of the parallel of 22° N. latitude.

457. The distribution of work for the season was arranged as follows:—

Captains Renny-Tailyour and Gordon to conduct triangulation from Wuntho to Kamaing *viâ* Katha and Mogaung.

Mr. Barckley to carry on triangulation in the Upper Chindwin district northwards from Kendat, and to supervise the work of Mr. Adams and three surveyors in that district.

* Captain Jackson, who held charge of the party during the field season, reports well of the work done by Messrs. Kitchen and Doran. Of the surveyors and sub-surveyors, he specially mentions Mahmud Hosein, Kudratullah, Abdul Rahim and Nuruddin.

Mr. Kennedy and one surveyor to accompany the column under Major Dalzell, which was to start from Bhamo on the 30th November 1891 to explore the Hukong valley.

" George and three surveyors to work in the Katha district.

One surveyor was deputed to complete the survey of Yeu district, another to make a survey of the Thibaw State, and two others to be attached to Police columns in the Môngmit State and the Kyaukkwe valley.

458. The programme laid down was on the whole satisfactorily carried out, although the work was retarded to a certain extent by the ill-health of some members of the party, and by the unfavourable conditions of the weather during the latter months of the field season.

459. The total area surveyed amounts to 24,075 square miles on the $\frac{1}{4}$ inch scale, made up as follows:—

	Square miles.
Upper Chindwin district	5,000
Yeu district	1,900
Katha district	6,425
Bhamo district	4,350
Ruby Mines district	500
Northern Shan States	2,150
Hukong valley	3,750
TOTAL	24,075

460. The triangulation executed covered an area of 7,100 square miles, of which 2,500 square miles was in the Upper Chindwin district and 4,600 square miles in the Katha and Bhamo districts, and it was carried out under considerable difficulties owing to the forest-clad nature of the country. In the Katha and Bhamo districts the series was taken mainly along the proposed line of railway from Wuntho to Mogaung and thence to Kamaing.

461. Captain Renny-Tailyour was engaged on the latter triangulation during the first half of the field season, and was accompanied by Captain Gordon, who executed a plane-table reconnaissance of the route taken. On the completion of this work, Captain Renny-Tailyour returned to Mandalay to take charge of the party, and was subsequently engaged in arranging for the requirements of the several detachments and in inspecting the work of the members as far as circumstances permitted, while Captain Gordon was deputed to the Katha district to supervise the work which was being carried on between Katha and the Chindwin river. He visited and checked the work of Messrs. George and Adams and of three sub-surveyors, and rendered invaluable assistance in securing combined work.

462. After receiving orders to join the Maingkwan column, Mr. Kennedy with one sub-surveyor proceeded *viâ* Bhamo to Sinbo, taking observations on various points *en route*. He proceeded on the 15th December with a detachment to Mogaung and met the main body of the column on the 19th. From Mogaung the expedition took a north-westerly direction, reaching Laban on the Namkong river on the 30th December, where a halt was made, and opportunity was taken to make surveys of the neighbouring country. Here he was obliged to send back the sub-surveyor whose health had broken down. Laban was left on the 6th January, and the expedition proceeded across the watershed *viâ* Sadusot into the Hukong valley, and on to Maingkwan, which was reached on the 9th. Here Mr. Kennedy measured a base line and took observations for latitude, and also made various short excursions into the surrounding country and surveyed it as far as the Tanaika river. On the 14th January the column was joined by another under Mr. Needham, which had come from Assam: a traverse of the route taken by this column had been kept, and was incorporated by Mr. Kennedy with his work.

Expeditions were thence made to Lalaung, 'Ntup'nsa, Ningbyen and Saraw, the most important villages in the valley, and the column left Maingkwan on the 13th February in two detachments. Mr. Kennedy accompanied the one which proceeded along the Chindwin into the Taro valley and *viâ* the Jade mines back to Mogaung.

During the expedition Mr. Kennedy succeeded in reconnoitring 3,750 square miles of new country, having triangulated 600 square miles on his way up from Bhamo to Mogaung. After returning from the expedition he surveyed a further area of 1,000 square miles between Mogaung and the Irrawaddy. Extracts from Mr. Kennedy's report on the country traversed by the Maingkwan column will be found in the appendix.

463. The party left Mandalay for the recess on the 20th May 1892, and arrived at Bangalore on the 27th May. It was engaged during the recess season in the computations appertaining to the triangulation executed during the field season and in drawing fair maps. Seven new editions were completed, *viz.*, sheets Nos. 22 S.W., 23 N.W., 23 S.W. of the North-Eastern Frontier Series, and 4 N.W., 4 S.W., 15 S.E., and 1 N.E. of the South-Eastern Frontier Series.

A practical course of instruction for the apprentices and younger surveyors was carried out under Mr. Barckley.

464. The health of the party was not so good as usual, fever being very prevalent among its members. Two sub-surveyors had to be invalided—one in the middle of the field season and the other on return to recess quarters—while two others had to go to Mandalay for medical treatment during the field season. Three *khalásis* died of sickness, and one from accident during the season.

465. As already mentioned in paragraph 454, the recess office of the party was inspected by the officiating Surveyor-General, together with that of No. 11 Party, in the month of August, and was found to be in a high state of efficiency.

466. The ensuing field season will, in all probability, see the close of the first survey of Upper Burma, which has been carried out by these two parties, as there are now but few gaps left in the topography. A little also remains to be done for the triangulation, and that little is so laid out as to throw light upon some of the discrepancies incidental to a first and hurried survey of a country, and will render it possible to sift out to a great extent what is really reliable and worthy of permanent record from what is ephemeral, and only designed to meet the wants of a geographical survey.*

OPERATIONS WITH THE ISAZAI FIELD FORCE.

467. A small survey detachment accompanied the column under Sir William Lockhart, K.C.B., which operated against the Isazai tribes in the Indus Valley during the month of October 1892.

Personnel.

Captain R. A. Wahab, R.E., Deputy Superintendent, 1st grade, in charge.
Asghar Ali, sub-surveyor.
Duffadar Lall Singh, soldier-surveyor.

468. The survey party joined at Derband on the 28th September 1892. One surveyor, Duffadar Lall Singh, 19th Bengal Lancers, remained at Derband to revise the survey of the ground between Derband camp and that surveyed on the 2-inch scale during the last expedition, and Captain Wahab with the remainder of the party accompanied the force throughout its advance.

469. Owing to the short time the troops remained across the border, there was little opportunity for extending the survey; some valuable information was, however, gained during the few hours available at Baio, where it was found possible to sketch in, approximately, on the $\frac{1}{2}$-inch scale a considerable extent of country in the Chamla and Buner valleys covering an area of 250 square miles; and at the same time to survey on the 2-inch scale the ground in the neighbourhood of Baio and to fix the position of several of the Hasanzai and Chagarzai villages on the western side of the Baio-Duma range.

* Captain Renny-Tailyour reports on his assistants as follows:—

"Captain Gordon proved himself most capable and zealous in his work, and is now quite fitted for the charge of a party.

"It is creditable to Mr. Barckley that, in spite of much sickness among his men, his section brought in such a large out-turn of work, *viz.*, 5,300 square miles of detail survey and 2,500 square miles of triangulation.

"Mr. Kennedy as usual proved himself a first-rate reconnoitrer, and maintained his reputation for zeal and energy. His talents as a draftsman are well known.

"Mr. George is a neat worker, and his out-turn was on the whole satisfactory.

"Mr. Adams appeared to be diligent and painstaking, but the difficulties of the country, added to his want of experience, rendered his work of little value. The native surveyors are generally well reported on, the work of Sher Shah, Ikbaluddin, and Mahomed Latif being specially commended."

470. This survey shows that the Hasanzai territory south-west of the Baio hill extends further than was supposed; the whole spur on which Punar and Nask lie, down to Wano on the left bank of the Barandu river, being Hasanzai. The *nala* running due west from Baio past the village of Maliar appears to be the boundary between Hasanzai and Chagarzai lands, the latter extending up to the high spur from Duma which bounds the view to the north-west; beyond that, Buner territory commences, but as far as could be ascertained no Buner village lies within two miles in a direct line from Baio.

471. The general character of the country between Baio and Buner is similar to that of the hills along the Indus valley. High spurs from the Duma range descend steeply to the Barandu, the hill sides are generally bare and stony but with villages and terraced fields on the gentler slopes and occasional patches of pine forest. The Buner and Chamla valleys, as far as could be seen, are open, fertile plains with numerous large villages and orchards. Their elevation rises from about 2,000 feet above sea level at the junction of the two valleys near Chirorai, to some 3,000 at the head of the Chamla valley, and 4,000 or 5000 feet at the head of Buner. The former valley is about 18 miles in length, the latter about 30. The hills enclosing both valleys are well wooded.*

* Captain Wahab reports that both the native surveyors worked hard and well. Asghar Ali is a quick and accurate topographer. Duffadar Lall Singh is a hard-working and efficient surveyor and an excellent non-commissioned officer.

Summary of the out-turn of work of the

Scale of Survey.	Number of Party.	Locale of Field Operations.		TRIANGULATION. Instrument used.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	Secondary—in which each angle is usually observed on two zeros. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Tertiary—in which two angles of each triangle are observed. Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.
32 inches=1 mile	Detacht. of 5	Garhwal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16 inches=1 mile	2	Chittagong	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Tippera	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	3	Sagaing	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Shwebo	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4	Jalpaiguri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Darrang	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lakhimpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kamrup	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sibsagar	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sylhet	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Mergui	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Tavoy	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Balasore	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	Cuttack	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Puri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Balaghat	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	9	Bhandara	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Mandla	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Minbu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Magwe	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forest)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detacht.	Burdwan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bankura	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Do.	Muzaffarpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Champaran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 inches=1 mile	4	Jalpaiguri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	Kolhapur City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forest)	30	7″	458	227	2	2	256	600	14	0·5	256	469	911	0·5	469
6 inches=1 mile	15	Baluchistan	...	6″	18	4	0·7	0·8	4	9	22	1·7	4	22	38	1·4	20
4 inches=1 mile	4	Jalpaiguri (Forest)	...	...	684	93	0·9	0·9	85	146	20	0·6	86	584	969	0·7	584(c)
		Bhutan Boundary	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	14	Hoshangabad (Forest)	...	6″	150	29	3·7	3·7	29	64	13	0·8	29	5	5	...	4
	17	Bombay (Forest)	35	7″	540	118	0·2	0·2	114	309	13	0·3	114	511	782	0·5	193
	18	Himalayas	...	7″	1,196	152	2·6	...	140	242	18	0·5	140	344	473	0·9	335
	19	Madras (Forest)	...	5″ & 6″	...	...	...	...	...	...	...	...	...	...	...	...	...
	20	Lower Burma (Forest)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detacht.	Bankura	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 inches=1 mile	2	Chittagong	40	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4	Jalpaiguri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Brahmaputra islands, etc.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	Gujarat	...	10″	300	26	...	...	26	56	5	0·4	21	131	222	1	44
		South Maratha country	45	8″	1,810	82	...	...	82	150	8	0·4	82	218	480	0·5	218
	15	Baluchistan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Himalayas	...	7″	617	83	0·1	0·1	73	339	11	0·5	35	611	1,027	0·5	341
	20	Lower Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1 inch=1 mile	3	Upper Chindwin	...	7″	106	...	...	...	...	...	...	...	...	...	...	...	...
	Detacht.	Mergui	50	6″	320	21	...	...	9	13	20	1·5	9	2	4	3	2
½ inch=1 mile	15	Baluchistan	...	6″	4,900	29	95	178	27		20	0·8	24	73	103	1·8	44
	Detacht.	Aden	...	6″	7,000	19	67	60	17	41	17	0·3	17	87	164	0·7	60
	Do.	Hazara border	...	...	...	...	...	...	...		...	...	...	...	...	...	...
¼ inch=1 mile	11	Upper Burma	...	6″	6,400	33	...	...	15	40	36	2	4	56	101	3	24
	15	Baluchistan	55	6″	7,500	10	170	178	14	24	4	0·02	14	30	45	0·04	28
	21	Upper Burma	...	6″	6,500	33	45	50	...	...	...	...	...	113	227	0·7	131
	24	Upper Burma	...	12″ (new)	4,300	14	...	...	...	...	...	...	...	...	...	...	...
	25	Bombay and Central Provinces	58	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	42,799	972	...	...	891	2,087	...	...	835	3,256	5,571	...	2,497

Field Parties during the year 1891-92.

SPIRIT-LEVELLING OPERATIONS.				TRAVERSING.					DETAIL SURVEY.						Remarks.
Number of miles levelled over.	Number of permanent bench-mark stones embedded.	Number of Trigonometrical stations connected with lines of levels.	Number of permanent points fixed as bench-marks.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per stations in seconds.	Average linear error per *mile*.	Square miles of village survey.	Area in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test lines.	Number of villages.	Number of fields.	Average size of field in acres.	
...	...	...	...	12,069	2,541	7	0·4	578	232	...	1,584	1,500	9,62,441	·10 (*c*)	(*a*) Calculated on the cultivated portion only.
...	...	...	...	13,603	1,360	6	0·4	297	675 (*b*)	...	1,179	434	22,91,185	0·14	(*b*) Includes 187 square miles of skeleton boundary work.
...	...	...	...	5,225	860	14	...	150	...	...	...	851	...	...	
...	...	...	...	15,342	3,582	6	0·4	1,219	1,818	...	3,752	1,150	10,01,010	0·64 (*a*)	
5	...	...	...	11,995	2,866	...	...	800	...	...	...	...	...	...	(*c*) 7,513 additional heights determined by clinometer.
...	...	...	...	666	72	1	3·6	5	23	...	47	92	5,797	2·31	
...	...	...	...	589	137	3	0·3	81	310	...	885	326	83,440	2·37	
...	...	...	...	3,276	964	5	0·6	269	269	...	748	319	96,704	1·78	
...	...	...	...	...	...	...	...	...	27	...	108	31	7,737	2·23	(*d*) Tested *in situ*.
10	...	...	...	2,587	466	1	...	150	150	...	336	140	25,123	3·82	
...	...	...	...	8,259	1,267	5	0·7	347	72	...	70	77	14,816	3·11	
...	...	...	...	7,427	1,553	6	0·5	423	550	...	1,135	382	4,80,099	0·38	
...	...	...	...	7,369	976	4	0·5	187	150	...	813	157	65,427	0·49 (*a*)	
...	...	...	...	10,575	1,715	3	0·3	408	310	...		342	2,84,573	0·42 (*a*)	
15	...	...	...	13,938	2,903	2	0·3	588	...	...	...	...	...	...	
...	...	...	...	33,519	5,901	2	0·2	1,252	1,095	...	5,337	2,233	19,22,884	0·36	
...	...	...	...	3,905	756	0·5	0·2	167	307	...		612	4,51,111	0·43	
...	...	...	...	17,140	2,574	5		1,215	...	...	...	399	...	...	
...	...	...	...	14,005	2,648	5	0·2	922	...	...	...	418	...	...	
20	...	...	...	29,465	4,597	5		2,174	...	...	...	876	...	...	
...	...	...	...	27,647	4,086	6	0·4	1,288	784	...	1,761	392	5,54,911	0·63 (*a*)	
...	...	...	...	3,138	568	4	0·4	156	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	40	149	40	...	...	...	
...	...	...	...	175	34	...	...	7	2	...	22	3	5,656	0·22	
25	...	...	...	...	...	...	...	...	11	...		44	40,347	0·18	
...	...	...	...	24,537	3,988	3	0·4	1,247	...	...	...	2,144	...	...	
...	...	...	...	5,302	1,227	5	0·1	363	...	...	...	238	...	...	
...	...	...	...	...	...	...	...	...	17	86	...	...	...	...	
...	...	...	...	...	...	...	...	...	11	...	...	...	...	...	
30	...	...	...	816	238	11	0·9	...	202	197	170	...	...	...	
...	...	...	...	...	...	...	...	...	15	31	10	...	...	...	
...	...	...	...	...	...	...	...	...	327	81	...	...	...	...	
...	...	...	...	...	76	...	...	...	25	...	...	...	...	...	
...	...	...	...	3,856	574	9	2·5	...	483	92	219	...	...	...	
35	...	...	...	2,556	258	5	0·7	...	195	108	75	...	...	...	
...	...	...	...	...	...	...	...	...	290	55	37	...	...	...	
...	...	...	...	3,605	253	17	2·0	...	659	33	(*d*)	...	...	...	
...	...	...	...	10,521	477	3	6·8	...	226	141	78	...	...	...	
...	...	...	...	17,931	2,706	...	...	614	...	...	...	...	...	...	
40	...	...	...	...	...	...	...	...	194	...	...	...	...	...	
...	...	...	...	...	229	21	2	0·2	337	34	...	...	...	...	
...	...	...	...	...	...	...	...	...	23	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	106	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	841	20	149	...	...	...	
45	...	...	...	2,047	672	7	...	...	1,680	9	136	...	...	...	
...	...	...	...	...	...	...	...	...	26	5	...	...	...	...	
...	...	...	...	...	...	...	...	...	239	30	10	...	...	...	
...	...	...	...	3,507	159	5	6·8	...	68	57	12	...	...	...	
...	...	...	...	...	...	...	...	...	106	3	...	...	...	...	
50	...	...	...	318	31	...	...	...	765	7	...	...	...	...	
...	...	...	...	...	...	...	...	...	603	2	(*d*)	...	...	...	
...	...	...	...	...	...	...	...	...	,426	0·25	...	...	...	...	
...	...	...	...	...	...	...	...	...	250	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	18,002	...	85	...	...	...	
55	...	...	...	...	...	...	...	...	19,084	0·16	(*d*)	...	...	...	
...	...	...	...	...	...	...	...	...	24,076	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Trigonometrical operations only.
58	452	48	12	481	...	...	...	...	...	...	...	...	...	...	
	452	48	12	481	3,18,139	53,106	...	...	14,929	80,101		18,776	12,661	82,93,281	...

Statement showing the cost-rates of work executed by the

Number of party.	Nature and *locale* of Field Operations.	Cost-rate per square mile in rupees.									
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of							
				1/2″	1″	2″	4″	6″	8″	16″	32″
	Topographical Surveys.										
2	Chittagong	...	...	...	...	23·1	...	...	...	92·5(*a*)	...
3	Upper Chindwin	...	...	...	56·4	...	...	...	...	...	...
4	Jalpaiguri	...	...	...	...	67·9	...	...	139·8	...	...
6	Brahmaputra islands, etc.	...	...	...	...	13·7	...	...	...	...	...
7	Amherst	...	...	...	...	45·3	...	...	...	...	...
10	Belgaum	4·7	9·3	...	...	15·0	...	...	100·3	...	...
	Gujarat	14·2	...	...	...	23·8	...	...	...	...	...
15	Baluchistan	2·8	...	40·1	...	100·0	...	151·0	...	...	...
18	Himalayas	7·3	...	...	...	...	99·1	...	...	...	...
		13·5	...	...	...	50·8	...	...	...	...	...
Det.	Mergui	...	...	...	71·7	...	...	...	...	...	...
Det.	Aden	1·5	...	5·2	...	...	...	...	...	...	...
	Forest Surveys.										
4	Jalpaiguri	...	...	...	...	...	120·1	...	...	...	...
14	Hoshangabad	21·1	22·5	...	...	...	118·8	...	...	...	...
17	Bombay — Northern Circle	5·8	26·5	...	...	...	...	...	145·3	...	...
		...	...	...	...	...	...	...	...	187·4	...
	Bombay — Southern Circle	22·1	18·7	...	...	...	85·4	...	...	...	...
		...	...	...	...	...	...	...	194·8	...	...
19	Madras	20·1		...	...	...	77·3	...	...	..	...
20	Lower Burma	35·2	150·6	...	...	66·2	175·3	...	...	...	...
	Cadastral Surveys.										
2	Chittagong	...	84·8	...	...	..	...	...	..	170·8	...
	Tippera	...	59·3	...	...	...	...	...	...	...	...
3	Sagaing	...	30·8	...	...	...	...	..	...	103·2	...
	Shwebo	...	30·5	...	...	...	...	...	...	...	...
Det. of 5	Garhwal	...	30·2	...	...	...	...	...	...	...	313·8
6	Kamrup, Sibsagar, Darrang, and Lakhimpur	...	31·0	...	...	...	...	...	...	53·1	...
	Sylhet	...	32·4	...	...	...	...	...	...	39·9	...
7	Amherst	...	42·5	...	...	...	...	...	...	118·6	...
	Mergui	...	119·6	...	...	...	...	...	...	137·2	...
	Tavoy	...	81·7	...	...	...	...	...	...		...
8	Balasore	...	17·7	...	...	...	...	...	...	...	...
	Cuttack	...	32·3	...	...	...	...	...	...	88·8	...
	Puri	...	51·4	..	...	...	...	...	...	109·8	...
12	Magwe	...	49·9	...	...	...	...	...	...	...	...
	Minbu	...	53·9	...	...	...	...	...	...	152·4	...
Det.	Burdwan and Bankura	...	52·8	...	...	...	...	...	...	191·0	...
	Traverse Surveys.										
9	Mandla, Bhandara, and Balaghat	...	15·7	...	...		...	...	...	...	...
Det.	Bihar	...	24·3	...	...		...	...	...	...	...

several Field Parties during the year 1891-92.

Rate in annas for traversing, detail survey and preparation of maps.		Cost-rates.					Total cost, exclusive of charges for instruments.	Remarks.
Scale 16″ = 1 mile.		Stone embedding.	Records (*Khanapuri.*)		Compilation of vernacular records, assessment statistics, etc.			
Per acre.	Per field.	Per square mile.	Per square mile.	Per field.	Per square mile.	Per field.		
a. p.	*a. p.*	₹	₹	*a. p.*	₹	*a. p.*	₹	
...	...	...	...	...	...	...	21,768	(*a*) Skeleton boundary survey.
...	...	...	...	...	...	...	5,982	(*b*) Includes ₹4,349 expended on 2-inch mapping of cadastral survey.
...	...	...	...	...	...	...	29,615(*b*)	
...	...	...	...	...	...	...	323	(*c*) Includes ₹11,734 expended on Gujarat survey general degree reports and ₹4,824 on instruction of apprentices.
...	...	...	...	...	...	...	4,804	
...	...	...	...	...	...	...	} 79,791(*c*)	(*d*) Includes ₹65,897 expended on the 1-inch geographical survey of 19,084 square miles.
...	...	...	...	...	...	...		
...	...	...	...	...	...	...	108,935(*d*)	(*e*) Includes ₹201 expended on trans-frontier surveys, ₹1,678 on instruction of soldier-surveyors, ₹2,220 on survey schools, ₹2,078 on revisionary survey, and ₹19,867 on arrears of mapping.
...	...	...	...	...	...	...	} 72,430(*e*)	
...	...	...	...	...	...	...		
...	...	...	...	...	...	...	54,868(*f*)	(*f*) Includes cost of surveying 61 tin mines on 8-inch scale.
...	...	...	...	...	...	...	34,577	(*g*) Includes ₹4,831 expended on classification of forests and soils of 483 square miles.
								(*h*) Includes ₹1,391 expended on work of Dakhin Shahbazpur and Serail Survey.
								(*i*) Includes ₹4,120 expended on demarcation and ₹1,560 on instruction in surveying.
								(*j*) Includes cost of demarcation.
...	...	...	...	...	...	...	42,284	(*k*) Includes cost of completing a portion of records of 1890-91.
...	...	...	...	...	...	...	87,152(*g*)	(*l*) The cost-rate, ₹313·8, under the head detail survey, includes both cost of cadastral survey and *khanapuri*.
...	...	...	...	...	...	...	} 69,326	
...	...	...	...	...	...	...		(*m*) Includes ₹4,287 expended on Rampur survey and ₹607 on 2-inch mapping of districts Jhansi and Tarai.
...	...	...	...	...	...	...		
...	...	...	...	...	...	...	72,706	(*n*) Includes ₹583 expended on demarcation, ₹2,140 on instruction of *mandals* ₹1,209 on revision surveys, and ₹2,921 on 2-inch mapping.
...	...	...	...	...	...	...	111,124	
								(*o*) Includes ₹575 expended on demarcation, and ₹447 on 2-inch mapping.
								(*p*) Includes ₹6,052 expended on demarcation, ₹1,550 on revision work, and ₹3,167 on 2-inch mapping.
								(*q*) Includes ₹23,635 expended on revision of irrigation survey of 1878-79, ₹26,821 on revision work of 1890-91, ₹1,992 on 2-inch mapping, ₹5,219 on Rampur and Jhansi mapping, and ₹1,068 on Cuttack city survey on 64-inch scale.
6 9	0 11	12·9(*j*)	...	...	...	...	114,177(*h*)	
...	...	...	...	...	...	...	14,575(*i*)	
3 3	3 9	3·7(*j*)	...	...	2·9	0 1	} 256,898	(*r*) Includes ₹2,002 expended on revision survey in district Prome and ₹8,627 on completing the traverse records of previous season of Lower Burma.
...	...	3·5(*j*)	...	...	...	...		
8 7(*k*)	1 3(*k*)	...	(*l*)	...	...	...	95,104(*m*)	
2 1	4 10	...	...	...	24·5	1 4	81,402(*n*)	(*s*) Includes ₹970 expended on cadastral maps of previous season and ₹1,745 on copying *thak* maps.
1 10	5 7	...	...	...	25·5	2 9	16,973(*o*)	
4 0	1 6	...	...	...	...	...	} 212,809(*p*)	
6 5	3 2	...	...	...	...	...		
5 6	2 4	...	...	...	...	...		
...	...	6·5	...	...	...	...		
3 1	1 1	5·9	35·8	0 4	0·9	...	} 303,208(*q*)	
4 0	1 9	7·0	30·0	0 4	0·7	...		
...	...	4·2	...	...	...	...	} 216,426(*r*)	
5 2	3 3	3·9	...	...	4·4	0 1		
6 0	1 1	10·3(*j*)	97·8	0 5	16·9	0 1	45,954(*s*)	
...	...	2·2	...	...	...	...	77,133	
...	...	10·4(*j*)	...	...	...	...	55,891	

Particulars of Cadastral Surveys completed since 1890-91.

Districts.	Scale of survey.	Number of villages.	Area surveyed in square miles.	Number of fields in acres.	Average size of fields.	Cost, exclusive of demarcation and charge for instruments.	Rate per square mile.			By whom and when surveyed.
							Traverse survey.	Cadastral survey.	Cadastral survey with record of rights.	
Burma.	Mile.					₹	₹ a. p.	₹ a. p.	₹ a. p.	
Kyaukse	16″=1	484	550	509,857	0·69	178,309	85 2 11	227 6 4	...	Mr. G. B. Scott, during 1889-90.
Mandalay	„	183	584	424,247	0·88	115,250	56 5 5	143 3 6	...	Mr. G. B. Scott, during 1889-91.
Meiktila	„	642	563	376,925	0·96	107,895	43 8 2	147 4 5	...	Mr. G. B. Scott, during 1890-91.
Sagaing	„	1,184	1,818	1,001,010	1·16	256,222	35 8 5	103 2 7	...	Mr. G. B. Scott, during 1890-92.
Bengal.										
Jalpaiguri	„	1,734	782	730,909	0·68	369,801	65 8 4	...	392 11 2	Lieut.-Colonel S. H. Cowan, Colonel W. H. Wilkins, Captain G. B. Hodgson, and Mr. H. T. Hanby, during 1888-92.

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

472. These offices comprise —

(1) The Head-quarters offices at Calcutta.
(2) The Trigonometrical Branch Office at Dehra Dun.
(3) The Drawing Office at Simla.

A detailed description of the work carried on in each office is given below:—

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE AND ACCOUNTS.

Superintendence.

Colonel H. R. Thuillier, R.E., Surveyor-General of India.
Colonel G. Strahan, R.E., Officiating Surveyor-General of India, from 2nd August 1892.
Lieutenant-Colonel C. Strahan, R.E., Deputy Surveyor-General in charge Revenue Branch.
Lieutenant-Colonel J. E. Sandeman, S.C., Director of Bengal Surveys, from 1st April 1892.
Lieutenant-Colonel M. W. Rogers, R.E., Assistant Surveyor-General, up to 4th May and from 24th June 1892.
Colonel W. H. Wilkins, S.C., Officiating Assistant Surveyor-General, from 5th May up to 23rd June 1892.
Captain W. J. Bythell, R.E., Deputy Superintendent, 2nd grade, Personal Assistant to the Surveyor-General, up to 30th June 1892.
Mr. T. W. Babonau, Registrar.

Correspondence.

Mr. M. Francis, Head Clerk, up to 18th April 1892.
„ J. F. Burbridge, Head Clerk.
„ J. A. Vallis, Clerk.
Babu Kali Podo Banerji, Clerk.
„ Bani Madhub Banerji, „
„ Durga Narain Ghose, „
„ Ram Kisto Chunder, „
„ Chuni Lal Dey, „
„ Gopal Chander Dass, „
Mr. E. Bonnaud, „
Babu Kali Kristo Chunder, „ and 8 others.

Accounts.

Mr. C. O. Gray, Head Accountant.
„ T. E. Ware, Accountant.
Babu Bama Churn Chuckerbutty, Accountant, to 30th August 1892.
„ Raj Krishna Mukerji, Accountant.
Mr. E. D'Cruz, Accountant, from 1st September 1892.
Babu Hem Nath Dutt, Accountant, and 5 others.

473. The general direction of these offices remained in the hands of Colonel H. R. Thuillier, R.E., except during his absence on privilege leave from the 2nd August 1892 till the close of the year, during which period Colonel G. Strahan, R.E., officiated as Surveyor-General in addition to his other duties. The Revenue Branch section continued under the superintendence of Lieutenant-Colonel C. Strahan, R.E., during the year, and the General and Topographical Branch sections under that of Lieutenant-Colonel M. W. Rogers, R.E., and Colonel W. H. Wilkins at different times. Captain W. J. Bythell, R.E., held the office of Personal Assistant to the Surveyor-General.

474. On the 1st April 1892, the appointment of Director of Bengal Surveys was created, and Lieutenant-Colonel J. E. Sandeman, S.C., was appointed thereto. The administration of the several parties working in the Bengal Presidency was transferred from the Deputy Surveyor-General in charge of the Revenue Branch to the Director of Surveys in Bengal. Colonel Sandeman, however, obtained six months' leave from the 18th April 1892, and his duties during the period of his absence were performed by Lieutenant-Colonel C. Strahan in addition to his other duties.*

* The Assistant Surveyor-General reports as follows: —

Mr. T. W. Babonau, the Registrar, has superintended the office in a very satisfactory manner. Messrs. Francis, Gray and Vallis have given satisfaction in the performance of their duties. The clerks have also worked well. and the following are deserving of special mention: —Babus Bani Madhub Banerji, Chuni Lal Dey, Raj Krishna Mukerji, Kanti Chunder Sen, and Mohendro Chunder Aich.

The Deputy Surveyor-General reports that in the Revenue Branch Office, Mr. J. F. Burbridge continued to give satisfaction in the discharge of his duties; that Babus Kalipodo Banerji, Ram Kristo Chunder and Norendra Nath Mukerji are hard working and efficient, while Mr. E. Bonnaud is an intelligent and very steady assistant.

DRAWING OFFICE.

475. The Drawing Office remained in the charge of Colonel W. H. Wilkins, S.C., up to the 4th May 1892, when, on his assuming temporary charge of the Surveyor-General's Office from Lieutenant-Colonel M. W. Rogers, R.E., proceeding on leave, he made over the superintendence of the drawing office to Colonel J. R. Wilmer. On the return of Lieutenant-Colonel Rogers from privilege leave on the 24th June 1892, Colonel Wilkins again assumed charge of the office, which he retained for the rest of the year.

Personnel.

Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, in charge up to 4th May and from 24th June to 30th September 1892.
Colonel J. R. Wilmer, S.C., Superintendent, 2nd grade, from 5th May to 23rd June 1892.
Mr. G. A. McGill, Chief Draftsman, up to 4th January 1892.
Mr. S. M. Smylie, Chief Draftsman, from 5th January 1892, and Head Draftsman up to 4th January 1892.
Mr. A. G. Wyatt, Officiating Head Draftsman, from 5th January to 29th July 1892.
Mr. Lovell Pocock, Head Draftsman, from 30th July 1892.
Mr. G. D. Cusson, Draftsman.
„ W. Green, „
„ A. J. Musgrove, „
„ J. R. Adels, „
„ R. C. Sinclair, „
„ A. S. Bateman, „
„ A. J. Rodrigues, „
„ E. Dowling, „
„ E. Andrews. „

Native Draftsmen.

Babu Harihur Sen,
„ Mohesh Chandra Shaw,
Munshi Muttiullah,
Babu Purna Chandra Sen,
„ Gopal Chandra Roy,
„ Tincowry Sen, and 38 others.

Additional Establishment.

Mr. A. J. James, Draftsman, and 7 native draftsmen.

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty.

Mr. H. E. T. Keelan, Extra Assistant Superintendent, 1st grade.
Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade, from 1st December 1891 to 7th May 1892.
Mr. A. G. Wyatt, Extra Assistant Superintendent, 2nd grade, up to 4th January 1892, and from 30th July 1892.
Mr. W. C. Price, Extra Assistant Superintendent, 2nd grade.
Mr. G. Campbell, Extra Assistant Superintendent, 4th grade, to 6th November 1891, and from 24th June to 23rd September 1892.
Mr. P. White, Sub-Assistant Superintendent, 1st grade, to 3rd March 1892.
Mr. E. J. Martin, Sub-Assistant Superintendent, 1st grade.
Mr. C. W. Seyers, Sub-Assistant Superintendent, 1st grade.
Mr. W. H. D. Ewing, Sub-Assistant Superintendent, 1st grade, to 19th November 1891.
Mr. O. C. Ollenbach, Sub-Assistant Superintendent, 3rd grade, from 23rd November 1891.

476. In January, Mr. G. A. McGill, the Chief Draftsman, who had been in indifferent health for many months, died. He had served for 36 years in the department and for the last seven years had held the post of Chief Draftsman. Throughout his service, Mr. McGill has borne a high character and has always carried out the duties entrusted to him with satisfaction to his superiors. Mr. S. M. Smylie was then appointed Chief Draftsman, and Mr. Wyatt to officiate as Head Draftsman until the arrival of Mr. L. Pocock from the Dehra Office on 30th July 1892, when the latter officer was appointed permanently to this post.

The principal work of the three sections into which the office is divided is reported on separately, and a detailed statement of the work executed in each section is given in the appendix.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

477. The maps of Burma on various scales have again formed the principal work of this section. Three sheets, on the 8-mile scale, Nos. 2, 4 and 6 of the South-East Frontier series, have been compiled and completed, from the latest edition of the $\frac{1}{4}$-inch scale maps, while sheets No. 1, 4th edition, No. 3, 2nd edition, Nos. 5 and 23 of the North-East Frontier series, are in progress. The preparation of these maps has again thrown a great deal of labour on this section, as the supply of fresh materials, received annually from the officers of the Survey and Quarter Master General's Department, necessitates the compilation of new editions.

478. It was stated in last year's annual report that the 2nd edition of the map of Burma and adjacent countries, on the scale of 1 inch = 32 miles, was completed. The publication was held in abeyance until the divisional and other boundaries could be received from the authorities in Burma with a view to their being inserted on the map. Advantage was taken of this unavoidable delay to bring the map up to date by the insertion of fresh material. Eventually, as there seemed no hope of receiving these boundaries, and as the map was much wanted, a preliminary edition was published.

479. The compilation of the map of Upper Burma, on the scale of 1 inch = 16 miles, commenced in 1891, is very nearly completed. It comprises the country between the parallels of 18° and 28° North latitude and the meridians of 92° and 101° East longitude, and it is expected that the map will be published by June 1893. This map is an entirely new compilation; so many changes having been made in the orthography of village names, and so much new topography having been supplied, it was considered preferable to compile a new map than to attempt to alter the old one, which had already borne the changes of five editions; moreover, the new map will show considerable additional country, as it embraces the country from the Koladyne river on the west to the Mekong (Cambodia) river on the east.

480. It was stated in last year's annual report that the 3rd edition of the 32-mile map of India was expected to be published by June 1892. The drawings have all been completed, but the publication has been delayed in consequence of the want of orders from the Government regarding the frontier boundaries that are to be inserted, and these are still awaited.

481. The skeleton railway map, on the 64-mile scale, which was prepared last year for the Director General of Railways, showing the names of all railway stations throughout India and Burma, has been corrected up to June 1892. After a few additions have been made it will be sent to press. This edition will shortly be published and will prove useful to the general public.

The railway map of India, on the scale of 1 inch = 48 miles, has been brought up to date, to be adopted in lieu of the 32-mile railway map of India, which is held in abeyance until the 3rd edition of the map of India on that scale is completed.

482. The Postal maps of the Province of Bengal and of the Eastern Bengal Circle, on the scale of 1 inch=4 and 8 miles, were prepared for the Post Master General and Deputy Post Master General, respectively.

483. The new compilation of the 16-mile provincial map of Bengal, Behar, Orissa, and Chota Nagpur, which has been in hand for some years, has been brought up to date and completed. This will be a most useful map for the general public.

484. The preparation of the maps for the new editions of Aitchison's Treaties, required by the Foreign Department, has continued during the year. Fourteen maps are completed and three are in progress, which will soon be sent to press.

485. The maps of the reconnaissance surveys in Somali land, on various scales, done by Captain Swayne, R.E., the preparation of which for reproduction was undertaken at the request of the Foreign Department, have been finally completed. There are in all seven maps, and it has taken a considerable time to prepare them.

486. The preparation of maps for other departments during the year has not decreased and still employs a large proportion of the staff. In last year's report it was intimated that the Government of India would be addressed on the subject of sanctioning a larger establishment, to be entertained with a view of meeting these yearly increasing demands. It is a matter of great satisfaction to be able to state that sanction has now been given for an increase of sixteen draftsmen to the existing staff. By a new system of dividing the native draftsmen of the Drawing Office into two divisions,—the senior beginning on a salary of R25 rising to R125, and the junior beginning on a salary of R10 rising to R50, in which recruitments will be separately made,—it is now possible to obtain a better class of men who are likely to become efficient for the higher class of work required, and who could not be attracted by the former low initial salaries. Already four pupils who have been trained in the Calcutta School of Arts have been entertained on probation in the senior section, and it is expected that in the course of two or three years the full establishment will be efficiently trained. The Superintendent of the School of Arts has been kind enough to promise to introduce the style of drawing required for the Survey Department into the curriculum of his school.

SECTION II.—REVENUE.

487. The ordinary work of this section consists in examining and preparing for photo-zincography the fair maps received from the field parties of the

Revenue Branch, in bringing up to date and re-publishing old maps, and in supplying data. This regular work has included the completion up to margin, from the latest survey materials, of several of the 1-inch scale standard maps of district Karnal in the Punjab, and of districts Bijnor, Moradabad, and the late district of Kumaun (now divided into the two districts of Naini Tal and Almora), in the North-Western Provinces. The old maps of district Lakhimpur, in the Province of Assam, have been compiled according to graticule in 1-inch standard sheets; and also two sheets of district Kamrup from the old 1-inch maps of the district for second editions. The map of British Sikkim, by Captain Harman, has been re-typed and the boundaries re-drawn for reduction, and incorporated with the old standard sheets of district Darjeeling for a second edition.

The 6-inch map of the city of Calcutta has been revised and sent to press for a third edition, and a 3-inch map of the same city, which was in progress during last year, has been completed and published.

488. Besides the regular work, a considerable amount of mapping has been done by this section for other departments. A map of Delhi and its environs, as existing before the mutiny, showing the British position during the siege of 1857, a map of Badli Sarai and a sketch map to illustrate the marches of the Delhi field forces in 1857, were prepared for the Military Department of the Government of India.

For the North-Western Provinces Government, the $\frac{1}{2}$-inch district map of Basti has been published, and that of Gorakhpur will shortly be sent to press; the maps of districts Mirzapur and Garhwal on the same scale are in progress.

489. The small computing establishment attached to this section has as usual been engaged on a great amount of miscellaneous work for other departments. Notwithstanding this, the arrears in the examination of the traverse records of the field parties have somewhat lessened; those of the three districts of Hoshangabad, Damoh and Jhansi, each embracing the operations of two field seasons, having been examined, although the assistance expected from the field parties has not been available, as no computers therefrom could be spared. The main reason for these arrears, a large quantity of which still remain to be examined, is due to the large amount of traverse surveys that have been done during the past few years to furnish a basis for settlement surveys. It is, however, confidently expected that help may be obtained from one or other of the field parties during the recess months and the arrears considerably decreased during the next two years.

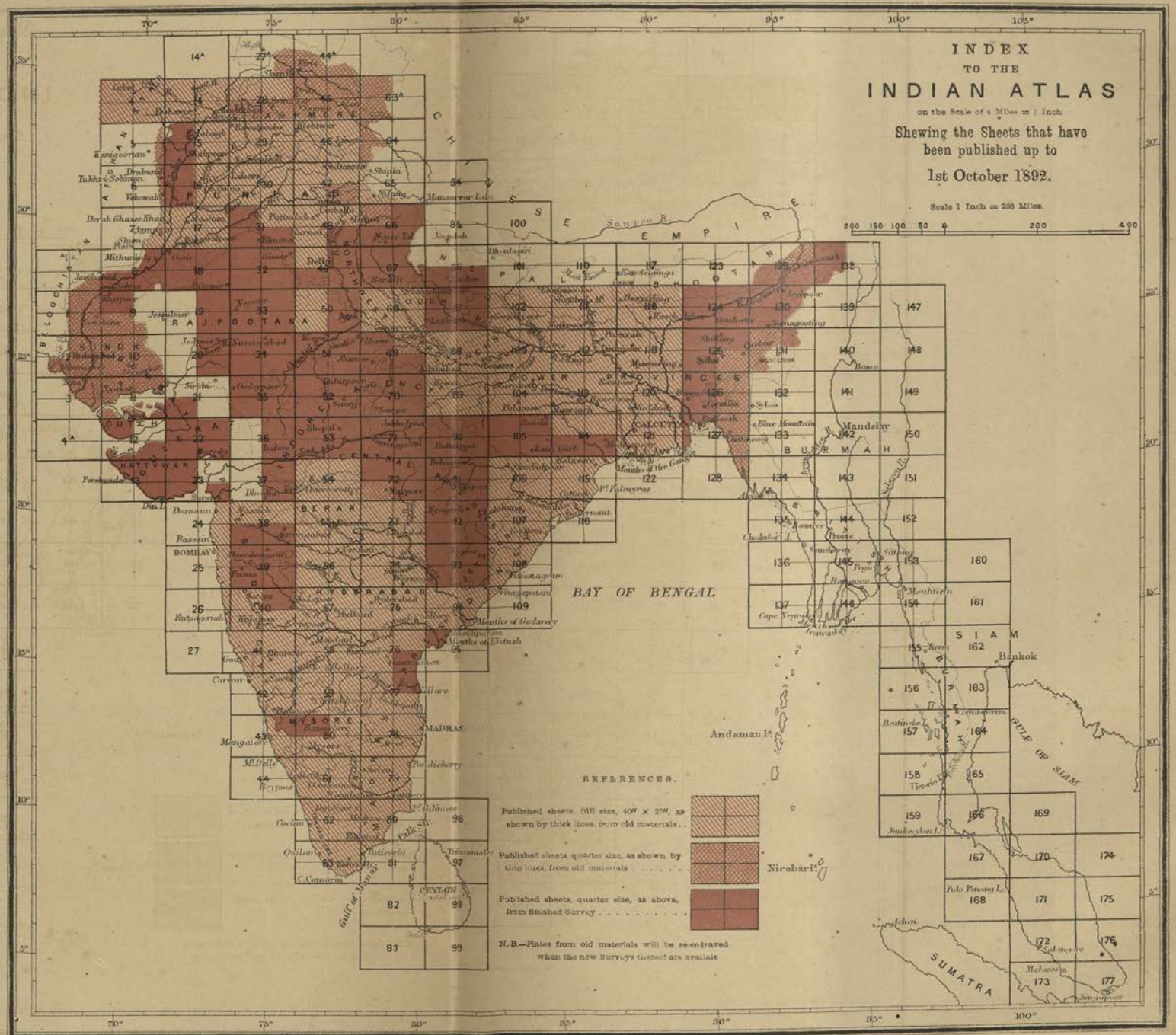
SECTION III.—CADASTRAL.

490. This section is employed in preparing the original maps of all the cadastral surveys for zincography and photo-zincography. The method is to examine the numbering of the fields and to observe if all holdings and divisions of land are correctly tabulated in the area statements. The total number of maps passed for publication during the year was 4,992, of which 1,331 were for zincography and 3,566 for photo-zincography, being an increase of 448 in the return of the previous year. Of these 4,897 were actually printed, 4,028 being coloured, examined, and sent for record with the Settlement Officers of the districts to which the maps belonged.

The maps completed and printed have been arranged and bound into 77 volumes for record in this office, as well as 44 volumes of maps of districts Cuttack and Bilaspur, which are not intended to be reproduced. Forty-eight volumes of printed cadastral maps of district Thongwa have been arranged in circles and townships, indexed, examined, bound and forwarded to the Chief Commissioner of Burma.

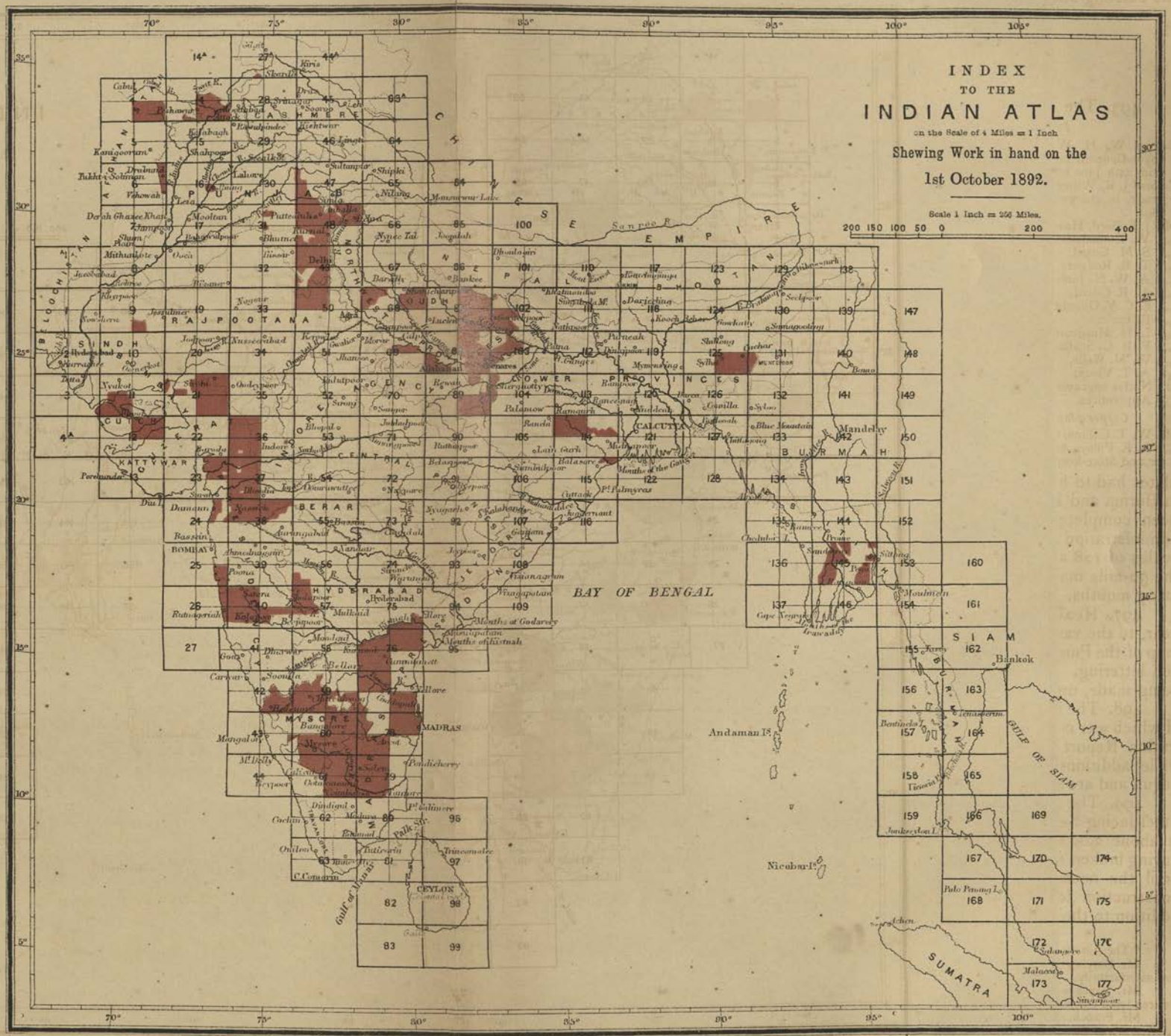
491. In consequence of the urgent demands made for the publication of the cadastral maps of the North-Western Provinces, Assam and Burma, no re-prints of former published maps were undertaken. The maps of the district of Gorakhpur have been completed with the exception of 6, in which some revisions have to be carried out.

492. At the end of the year there were 4,634 sheets in this office for publication, against 4,252 in last year, or an increase of 382. The work of examination and preparation of the maps of the current cadastral surveys is found to be


INDEX
TO THE
INDIAN ATLAS
on the Scale of 4 Miles = 1 Inch.
Shewing the Sheets that have been published up to
1st October 1892.
Scale 1 Inch = 266 Miles.
200 150 100 50 0 200 400
REFERENCES.
Published sheets, full size, 40′ x 2°, as shown by thick lines, from old materials..
Published sheets, quarter size, as shown by thin lines, from old materials . . . . . .
Published sheets, quarter size, as above, from finished Survey . . . . . .
N.B.—Plates from old materials will be re-engraved when the new Surveys thereof are available
BAY OF BENGAL
Andaman Is.
Nicobar Is.
SIAM
Bankok
MADRAS
CEYLON
SUMATRA
Mandelay
BURMAH
RAJPOOTANA
BOMBAY
HYDRABAD
MYSORE
BERAR
CENTRAL PROVINCES
NORTH WEST PROVINCES
BENGAL
Gulf of Martaban
Gulf of Siam

Reg. No. 604. S. I. D.—Dec. 92—550.

Litho. S. I. O., Calcutta.



Reg. No. 604, S. I. D.—Dec. 92—350.

Litho, S. I. O., Calcutta

greater than can be accomplished with the existing establishment, but as it is expected that the demands from the North-Western Provinces Government for printed maps will cease during 1893, and as the maps of the Bengal surveys are not to be printed, it is hoped that the arrears will be gradually worked off with the existing staff. *

ENGRAVING OFFICE.

493. The superintendence of this office was held for different periods by Colonels Wilkins and Wilmer, S.C. The supervision of the engravers has remained in the hands of Mr. J. Fulford, head Engraver, during the whole of the year.

Personnel.

Colonel W. H. Wilkins, S. C., Assistant Surveyor-General, in charge up to 4th May and from 24th June to 30th September 1892.
Colonel J. R. Wilmer, S.C., Superintendent, 2nd grade, in charge from 5th May to 23rd June 1892.
Mr. J. Fulford, Head Engraver.
„ W. Donaldson, Engraver.
„ S. M. Coard, „
„ T. B. Rodger, „
„ A. W. N. James, „
„ A. R. Coard, „
„ E. C. V. Ollenbach, „
„ E. Earle, „
„ L. H. Musgrove, „
„ F. R. C. Scallan „
„ W. M. Wells, „
„ A. T. Vieux, „
22 Native engravers
3 Apprentices.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate Printer.
„ A. E. Pilley, Assistant Copper-plate Printer and Store-keeper.

494. The out-turn of work, a summary of which will be found in the appendix, is a little in excess of last year, though the number of plates worked on is smaller.

495. Four quarter sheets of the atlas of India have been completed and published, 58 plates have been corrected with additions, while 43 others are in various stages of progress.

496. The 32-mile map of India, in six plates, referred to in para. 442 of last year's report, has been completed in readiness for electro-typing. The duplicate of No. 6 plate is completed and the other 5 plates are in various stages of progress. All the plates had to be enlarged, both on the east and west, to take in additional areas in Burma and Baluchistan. The duplicate plate of the 96-mile map of India has been completed as well as that of the 96-mile railway map of India for the administration report of the Railway Department. The maps of India on the scales of 128 and 256 miles have been in progress, but are still unfinished, as the 32-mile map, above alluded to, occupied the time of the best engravers for many months.

497. Heavy corrections and additions have been carried out, as in last year, to the various provincial maps on the scale of 1 inch = 16 miles. The map of the Punjab in four sheets and the map of Mysore are completed in outline and lettering. A duplicate of the latter by the electro-typing process is now being made, upon which the hills will be engraved.

498. The map of Darjeeling, on the scale of 1 inch = 4 miles, the out-lining of which was completed last year, is well advanced in lettering. Of the Administration Report maps, nine districts have been commenced and five completed, while additions have been made to 17. Many miscellaneous plates have been begun and are in various stages of progress.

499. The Copper-plate Printing Section pulled 18,967 impressions and the Steel-facing Section dealt with 158 plates. The number of impressions pulled is about 2,000 less than last year, which is due to two of the large presses having broken down and consequently been thrown out of work for some months until the necessary repairs were executed. A new press of very substantial construction for dry printing has been received from England, and with this addition to the office, the number of pulls can be much increased if necessary.†

* The Assistant Surveyor-General reports as follows on his assistants:—
Mr. Smylie, who became Chief Draftsman on the death of Mr. McGill, has performed his duties very satisfactorily.
Mr. James in charge of the cadastral section, and Mr. Price in charge of the examining section, have also rendered efficient service. Messrs. Wyatt, Martin and Cusson have also done well.
Mr. Pocock, who assumed the office of Head Draftsman in July, has given the greatest satisfaction.
Among the European draftsmen all, except Messrs. Adels and Bateman, are well spoken of, and Babus Mohesh Chandra, Harihur Sen, Purna Chandra Sen, Gopal Chandra Roy, are favourably reported on; the native establishment generally have done good work.

† Mr. Fulford supervised the office in the most efficient manner. The European and native engravers are generally very favourably reported on.

CALCUTTA CITY SURVEY OFFICE.

500. This detachment has remained throughout the year under the supervision of the Assistant Surveyor-General, Drawing Office, Calcutta. Mr. D. Atkinson, who had been in immediate charge of the detachment almost from the commencement of the survey, retired on a superannuation pension on the 8th May 1892, and Mr. A. J. Wilson was appointed in his place.

Personnel :

Colonel W. H. Wilkins, S.C., Superintendent, 1st grade, in charge.
Mr. D. Atkinson, Extra Assistant Superintendent, 1st grade, up to 8th May 1892.
Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade, from 9th May 1892.
Mr. A. B. Smart, Sub-Assistant Superintendent, 2nd grade, up to 18th February 1892.
Babu Sarat Chunder Sen, Sub-Assistant Superintendent, 3rd grade, from 1st April 1892.
15 draftsmen and others.

501. In last year's report it was recorded that the undermentioned work remained to be completed :—

(1) The house-to-house enquiry as to names and addresses of proprietors, and the investigation of the boundaries of about 300 holdings in the Sutanoti *taluk*.
(2) The completion of the 459 original field sheets, 228 of which, comprising the southern division, were nearly finished, and the remaining 231 sheets, comprising the northern division, being well advanced.
(3) The survey and adjustment of about 1,550 holdings, of which the proprietors were not present at the time of survey.
(4) The completion and publication of the 235 fair sheets.
(5) The completion of the register of proprietors.

502. The following progress has been made during the year under report :—

(1) The house-to-house enquiry has been completed.
(2) The colouring of the 228 sheets of the southern division has been finished, and that of the 231 sheets of the northern division only remains incomplete in those places where re-surveys have been made.
(3) In the survey and adjustment of boundaries, 1,386 holdings have been demarcated, of which 120 were situated in the Sutanoti *taluk* and 1,266 in the area under the Collector. Since last year, many other holdings have been found, and instead of about 1,550 left for survey, as was then supposed, there were really about 2,250. The total number of holdings demarcated since the commencement of the survey is as follows :—

Up to 30th September 1891 . .	20,398
During 1891-92	1,386
TOTAL .	21,784

There are probably about 864 holdings still left for final demarcation.
(4) Out of the 236 fair sheets, 12 have been completed and sent to press, and block XII of the southern division has been prepared and sent to the Municipal Office to be placed on view for two months before final publication, in accordance with section 20 of Act I of 1887. It should be explained that, in consequence of the reclamation of land near Prinsep's Ghât, one more has been added to the number of fair sheets, thus making the total 236 instead of 235, as given in last year's report. The reason why block XI has not been prepared, as promised in last year's report, is that there was great delay in demarcating the boundary of Calcutta, which runs through both this and block XII.
(5) The fair register of the names of all proprietors, who were present at the time of survey, has been completed up to date.

503. During the year, the claims of 548 disputed boundaries were filed in the Court of the Assistant Superintendent under the Calcutta Survey Act. Of these, 281 were decided. Rai Bahadur Kally Churn Ghose, Assistant Superintendent of the Calcutta Survey, having retired on the 25th April 1892, Babu Tarini Kumar Ghose was appointed in his place. He began his new duties on the 28th May, and he has settled 148 cases since that time.

504. The preparation of the 16-inch map direct from the original fair sheets by heliogravure, a specimen of which was given in last year's report, was found to entail so much work of a very difficult nature in obliterating the small superfluous details and correcting the negatives that the method was considered to be impracticable. Another experiment was then made; blue prints of the fair sheets reduced to about one-half were supplied to the Drawing Office and were then re-drawn specially for reduction to the 16-inch scale. The results, however, were not satisfactory, and were not suitable for the heliogravure process. It is now arranged to utilise printed proofs of the fair sheets and paint out all unnecessary detail and all names. These proofs will then be pieced together in groups of four, and reduced by photography to the 16-inch scale; they will then be etched on copper by the photo-etching process. The names of streets, etc., will be engraved on these copper-plates by hand. This has not yet been given a trial, as it has been postponed on account of the press of other work connected with the original fair sheets and maps of blocks.

505. During the month of August 1892, the office was inspected by His Honour the Lieutenant-Governor of Bengal, when the difficulties connected with the demarcation of the boundaries of holdings, owing principally to the non-attendance of the proprietors, was explained to him. His Honour desired that section 6 of Act I of 1887 for the survey of the city of Calcutta should be more generally enforced. It was found in practice, however, to be so extremely difficult to make sure that the necessary notices had been duly served upon the rightful proprietor or person having permanent interest in the land that it was thought better to make use of the powers conferred by this section with care, and now that the field survey has been so far completed that some of the fair sheets can be really finished and published, the delay caused by the want of demarcation, which not long ago extended more or less into every sheet, has to a great extent ceased to exist, and it is believed that by about March 1893 the whole of the boundaries will have been demarcated without having to resort to extreme measures. There will then remain the completion and final examination of the fair sheets, which requires a great amount of careful examination on the part of the draftsmen and of the Extra Assistant Superintendent in charge, who is finally responsible for their accuracy. As the sheets are finished they will be sent to press, and will then be made up into block maps and sent to the Municipal Office, where they will be on view as already explained. It is hoped that, so far as this department is concerned, the whole work will be completed during the year 1893.*

* Colonel Wilkins reports that Mr. D. Atkinson has always discharged his duties very satisfactorily, and that it was a matter of regret that he had to retire, as he was so thoroughly acquainted with the details of the work. His successor, Mr. A. J. Wilson, has been attentive to his duties and painstaking. Babu Sarat Chunder Sen has been of great assistance in the demarcation.

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

Personnel.

Colonel J. Waterhouse, S.C., Assistant Surveyor-General, in charge from 12th November 1891.
Mr. T. A. Pope, Deputy Superintendent, 4th grade, in charge up to 11th November 1891.

NEGATIVE SECTION.

Normal Establishment.

Mr. H. Haward, Head Assistant.
Munshi Ismail Khan, Assistant Photographer.
Mr. G. W. Mackie, Assistant Photographer, up to 30th August 1892.
Mr. E. Savedra, Apprentice.
One assistant photographer and two negative re-touchers.

Cadastral Establishment.

Mr. L. Lagnier, Photographer.
„ T. Lloyd, Offg. ditto.
„ C. D'Cruze, Asst ditto.
Three native assistant photographers and three negative re-touchers.

PHOTO-TRANSFER PRINTING SECTION.

Normal Establishment.

Mr. J. Harrold, Photographer.
Munshi Habibul Hossain, Assistant Photographer.
Mr. P. C. Michael, Apprentice.

Cadastral Establishment.

Mr. R. George, Photographer, and two assistant photographers.

SILVER PRINTING SECTION.

Mr. C. J. Meade, Apprentice, and one assistant photographer.

HELIOGRAVURE AND COLLOTYPE SECTION.

MR. A. W. Turner, Photo-engraver.
Mr. J. T. Meade, Collotype printer.
One assistant photographer, two engravers and three copper plate printers.

LITHOGRAPHIC DRAWING SECTION.

Mr. H. L. Lepage, Head Assistant.
Babu Umbica Churn Mukerji, Examiner.
Munshi Sobhan Baksh, and 24 other draftsmen.

ZINC-PRINTING SECTION.

Normal Establishment.

Mr. B. Mackenzie, Zincographer.
„ F. R. Vandyke, ditto
„ J. B Mackenzie, Assistant Zincographer.
One writer and 4 zinc correctors.

Cadastral Establishment.

Mr. E. A. Lefranc, Zincographer.
„ G. A. Lefranc, Apprentice.
One writer and nine zinc correctors.

LITHO-PRINTING SECTION.

Mr. D. Deas, Chromo-Lithographer.
„ U. S. Ravenscroft, Assistant Lithographer.

TYPE PRINTING SECTION.

Mr. E. DePyvah, Head Printer.

CORRESPONDENCE AND ACCOUNTS SECTION.

Normal Establishment.

Mr. W. Moore, Store-keeper.
Babu Kanny Lall Sen, Head Clerk and Accountant.
Babu Gopal Chunder Mukherjee, Clerk, and one other.

Cadastral Establishment.

Babu Nagendra Nath Mukerji, Clerk.
Babu Rajani Kanta Chatterjee, Clerk, and three others.

506. The office was under the charge of Mr. T. A. Pope from the commencement of the year till the 12th November, on which date Colonel Waterhouse returned from furlough and resumed charge. There have been no important changes in the *personnel* of the establishment during the year, and no casualties among the European assistants. Mr. G. W. Mackie was discharged on the 31st August for dishonestly bringing in outside work to be copied in the office.

507. Notwithstanding that the machine and hand presses have all been fully occupied during the year, it has been found exceedingly difficult to deal with the large amount of printing work in hand, and to meet the many urgent demands continually coming in from other departments. The difficulty is principally owing to the large increase in colour work, as each separate colour involves a separate printing, as well as in larger numbers of copies being asked for. It is hoped that the additional power gained by the new lithographic machine, which is now being put up, will enable the office to overcome these difficulties and keep abreast of the increasing work.

508. The general abstract of work turned out, given in the tabular statement below, again shows a large increase over the previous year in almost all items, though not to so large an amount as in last year.

General Abstract of work done during 1891-92.

TION.	Sheets or subjects.	Negatives and transparencies.	PHOTO-ZINCOGRAPHIC AND LITHOGRAPHIC PRINTING.								TYPE PRINTING.			SILVER AND OTHER PRINTING.		HELIOGRAVURE AND ELECTROTYPING.				Value.
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of Copies. Coloured.	Uncoloured.	Total.	Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	ec t ro	
																				R a. p.
Departmental maps and plans	1,152	1,440	1,049	375	333	82	130,244	14,709	110,036	124,745	8,615	1,318,597	678,968	415	2,357	9	1,517	5	14	69,196 0 0
Cadastral maps	4,956	3,634	3,648	4,966	4,966	...	149,979	...	139,819	139,819	...	...	...	...	...	...	...	...	...	68,479 14 0
Extra-departmental maps and plans	1,424	1,079	1,032	526	609	497	475,045	114,445	363,248	477,693	...	...	...	2,583	109	41	40,898	52	...	72,677 12 0
TOTAL	7,532	6,153	5,729	5,867	5,908	579	756,068	129,154	613,103	742,257	8,615	1,318,597	678,968	2,998	2,466	50	42,415	57	14	210,356 10 0
TOTALS of 1890-91	7,067	5,694	5,579	5,441	5,611	573	711,978	110,800	649,568	760,368	9,098	1,074,280	581,690	1,105	2,691	76	34,015	35	26	208,653 13 0
Differences	+ 465	+ 459	+ 150	+ 426	+ 297	+ 6	+ 44,090	+ 18,354	— 36,465	— 18,111	— 483	+ 244,317	+ 97,278	+ 1,893	— 225	— 20	+ 8,400	+ 22	— 12	+ 1,702 13 0

509. The increase in the number of subjects, negatives and zinc plates transferred and printed, is due to the larger number of cadastral maps reproduced, amounting to 580 sheets more than last year. Of the surveys in the North-Western Provinces 2,464 sheets, of Burma 1,715 and of Assam 777 sheets were printed. The increase is chiefly in the Burma sheets. Apart, however, from the increase of the cadastral work, there has been a large increase in the number of pulls from zinc and stone and in the number of coloured copies, though the uncoloured copies show a large falling-off, which does not affect the actual increase of work in the printing sections. In the type-printing section, the number of items set up again shows a decrease, though the number of pulls and copies shows a further very large increase, and in consequence it has been found difficult to get through all the demands ; it will soon be necessary to set up another printing machine to meet the increased demands for forms, etc. The silver printing section shows a large increase in silver printing on account of 2,136 silver prints supplied to the Secretary of State for the illustration of the late Dr. Forchhammer's reports on the antiquities of Arakan and Pagan, though the number of blue prints has fallen off.

510. The completion of the third edition of the 32-mile map of India has again been delayed by further heavy additions and corrections, chiefly in sheets 1 and 4, but the publication is otherwise prevented by want of orders from the Government regarding the frontier boundaries to be shown therein. Among the provincial maps reprinted with corrections and additions may be noted Bengal, Behar, Orissa and Chota Nagpore, with additions and corrections to railways to August 1891, in 2 sheets, scale 1 inch=16 miles; a re-issue of the maps of Bengal (Eastern and Western), on the scale of 1 inch=8 miles; a third edition of the map of the North-Western Provinces on the scale of 1 inch=16 miles, in 4 sheets, corrected to March 1891. Maps of the Gorakhpur and Benares divisions, in 3 sheets, on the scale of 1 inch=4 miles, of the Rajshahye division on the scale of 1 inch=8 miles, and also of the Kumaun, Rohilkhand and Gorakhpur divisions, on the scale of 1 inch=4 miles, were printed. Maps of districts Shahabad, Sylhet and Patna, on the scale of 1 inch=4 miles, have been lithographed by transfer from the engraved copper-plates of the Atlas of India; while maps of the Sundarbans, in 2 sheets, on the scale of 1 inch=4 miles; Hooghly and Howrah, in 5 sheets, on the scale of 1 inch=1 mile; Benares in 3 sheets and Basti in 4 sheets, both on the scale of 1 inch=2 miles, have been photo-zincographed.

511. Of 430 standard sheets in hand, on various scales, 99 have been published during the year, exclusive of reprints. Of a large number of sheets, blue print proofs have been supplied for examination and correction, after which they will be transferred to zinc. Among the sheets published may be noted 7 sheets of Bengal, including 4 of district Mymensingh, on the scale of 1 inch to 1 mile; 4 sheets of Bombay surveys on the 1-inch scale and 3 sheets on the 2-inch scale; 5 sheets of Lower Burma survey on the 1-inch scale, districts Prome, Tharrawaddy and Henzada, and 4 sheets on the 4-mile scale; 3 sheets of the Central India and Rajputana surveys on the 1-inch scale; 2 sheets of the Central Provinces survey on the 1-inch scale and 11 sheets on the 4-mile scale; 3 sheets of the North-Western Provinces and Oudh survey, and 2 sheets of the Oudh revenue survey, on the 1-inch scale; 28 sheets of the Punjab surveys, on the 1-inch scale, in districts Ferozepur, Jullunder, Lahore, Montgomery, Faridkot, Ludhiana and Sikh States, Hoshiarpur, Umballa, Patiala and Hissar; 7 sheets of the North-Eastern Frontier on the 4-mile scale and 2 sheets on the 8-mile scale; 10 sheets of the South-Eastern Frontier on the 4-mile scale and 1 sheet on the 8-mile scale. The majority of these Eastern Frontier maps are new editions of sheets published before. Thirty sheets of the Madras forest survey maps, on the scale of 4 inches=1 mile, have also been published during the year.

512. Several sheets of the new survey of Calcutta have been reproduced to scale during the year, but as yet none of them have been printed off. The experiments noticed last year as under progress for preparing a reduced map by heliogravure were continued, but it was found that the system of re-drawing upon reduced cyanotype prints would not answer on account of the blue details coming up. This system, which had every promise of success, had therefore to be abandoned, and trials are now being made of a system by which the proofs

of the original sheets will be prepared for reproduction. The question is one which presents a good many difficulties in finding a successful method by which a complete re-drawing of the map may be avoided. A 3-inch map of Calcutta has been brought out, based on the 6-inch map. Other cantonment plans published are Kamptee and Satara, each in two sections, on the scale of 8 inches =1 mile, and Dinapore, in 2 sheets, on the scale of 6 inches=1 mile.

Besides these a large number of index-maps, technical charts and miscellaneous maps and items have been reproduced for departmental purposes.

513. The extra-departmental work again shows a very large increase, not so much in the number of subjects received as in the number of pulls, owing to the very large proportion of colour printing now required, and also to the much larger number of copies now asked for than was formerly the case. Where the demands formerly amounted to hundreds, they now amount to thousands. The amount of work done for the various departments is shown in the table attached to Colonel Waterhouse's report in the appendix, but the following items may be specially noticed. A very large amount of work has been done for the Railway Department, including three maps, on the scale of 1 inch=96 miles, showing railways, also railway systems and gauges, each of the latter being shown in many colours. The new railway map specially engraved for the purpose is now being used for obtaining transfers from the copper to be printed from stone. This saves a great deal of labour in preparing the maps, but nevertheless a large amount of correction is always required. A large number of drawings of girder bridges, and a railway specimen plan, have been lithographed in colour, besides diagrams of engines, carriages, etc., photo-zincographed. The demands of the Meteorological Department have again increased, and for the most part involve printing in two colours. Besides the regular work of printing the forms of the daily weather charts for India and Bengal, five plates monthly are printed for the *Monthly Weather Review*, besides plates for the *Cyclone Memoirs* and the *Annual Review*. In face of the numberless urgent demands from other departments, it has been found exceedingly difficult to meet these large regular demands. Nine maps have been prepared and copies printed off during the year for the new edition of *Aitchison's Treaties*. The printing of the maps and diagrams for the Leprosy Commission Report, of which 2,500 copies were required, 11 of the maps being in colours, has also been a severe tax on the resources of the office. Another heavy colour printing job has been the partial printing of copies of a series of 8 plates of native soldiers to illustrate the Historical Records of the Bengal Native Army: these are in several colours, and as they have had continually to make way for other more urgent work, the printing off has taken a long time and was not completed at the end of the year.

A new geological map on the scale of 1 inch = 96 miles, in 11 colours, has been prepared and proved, but copies have not yet been printed off; this will also be a heavy piece of printing work. A Coal and Iron map has also been prepared on the same scale for the Reporter on Economic Products. The usual maps for the Administration Reports, Bengal and the Punjab, all of which are in at least two colours, were prepared and most of them printed off.

A series of maps of British Guiana, north-western district of British Guiana, Guadeloupe, Jamaica, St. Lucia, Surinam, Martinique and Antigua, were reproduced by lithography and photo-zincography for Dr. Comin's Report on Colonial Emigration, but had not all been printed at the close of the year. The ordinary work of the year has been further increased by the preparation of maps and diagrams to illustrate the Reports on the Census Operations in Rajputana, Assam, and Berar, all the maps being in colours and those of the Rajputana States requiring special care in the preparation and printing of the colour stones.

A set of maps illustrating Professor Forrest's History of the Indian Mutiny of 1857 have been photo-zincographed, and one of them will be printed in colours.

Besides the above, several divisional maps of the North-Western Provinces and Oudh on the scale of 1 inch = 4 miles have been lithographed and printed, also a large number of plans of the grass *rukhs*; and plans of the Yenang Young, Yenang Yat, Twingon and Beme oil-fields were photo-zincographed. The value of all the extra-departmental work done was ₹72,677-12 against ₹61,944-3 in last year.

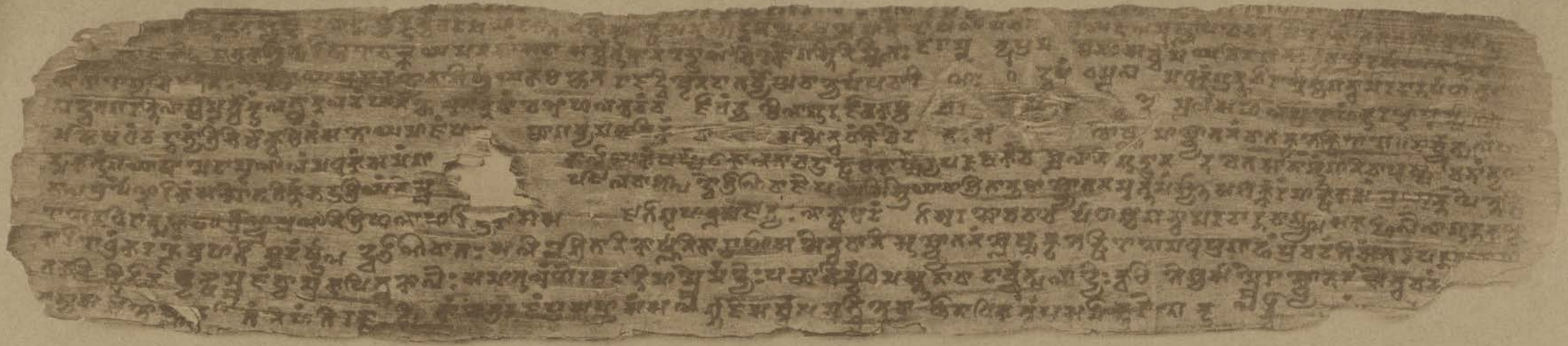
514. The heliogravure section has made steady progress during the year, though there is nothing very special to report beyond the extension of the use

The Bower Manuscript.

Part I. Leaf 4.

Plate IV

Obverse.



Reverse.

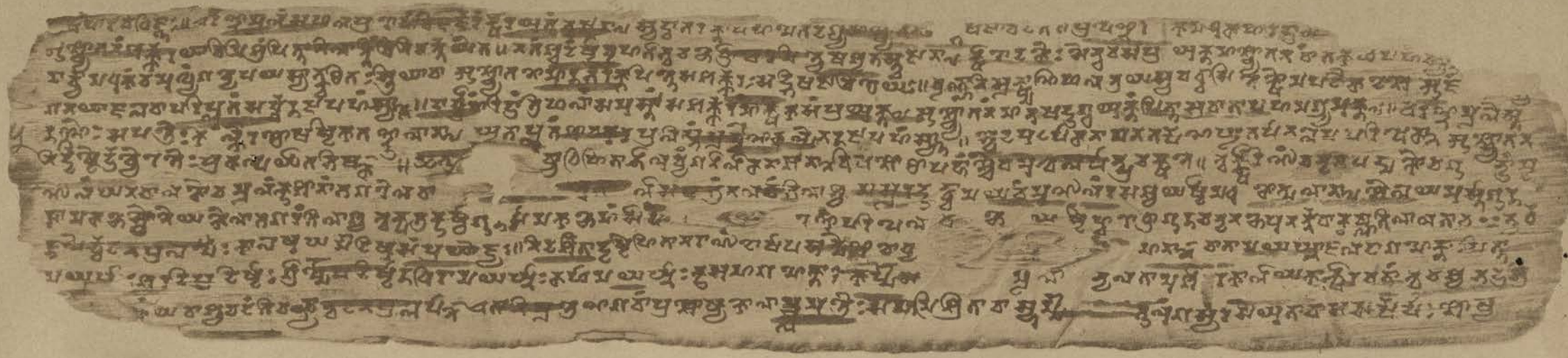


Photo-etching.

ORIGINAL SIZE.

Survey of India Offices, Calcutta, January 1893.

of photo-blocks. By the photo-etching process, 50 plates have been produced and 42,415 copies printed; 57 photo-blocks have been prepared and 14 plates electrotyped as matrices or duplicates. Eight plates of the Technical Art Series have been printed off and distributed. Forty-seven photo-blocks were prepared for the illustration of the Indian Museum Notes on Economic Entomology. The principal work of the year has been the reproduction of the manuscripts discovered by Lieutenant Bower in Western Turkestan, of which 13 plates have been prepared, as described in Colonel Waterhouse's report in the appendix: a specimen plate of this work is appended. A set of 12 plates of Fishes and Crustacea was prepared and printed to illustrate Dr. Alcock's Report on "The Zoology of I. M. S. S. 'Investigator.'" These plates were reproduced from the original Indian ink drawings and will show the value of the process as a substitute for lithography. The view of the tomb of Itmad-ud-Daula, Agra, given as a frontispiece to this Report, shows the result of direct enlarging from a small plate, and the application of heliogravure to architectural illustration. Further details of improvements in working, etc., will be found in the appendix.

515. The preparation of a revised proposal for the reorganisation of the office, and latterly ill-health, have prevented Colonel Waterhouse from completing his investigations on the production of reversed positives by the use of thio-carbamides in the developer, though the subject is not lost sight of. The principal experimental work done has been in connection with the very sensitive collodio-bromide emulsion process, noticed in last year's report, which might be exceedingly useful in the office for ordinary negative work, if a satisfactory means could be found of obtaining clear lines for line-work and also of retaining the sensitiveness of the plates in a dry state. Colonel Waterhouse's work in this direction is detailed in the appendix. Various new developing agents have been tried and experiments made upon the action of electricity in the formation and development of the latent photographic image, but these were interrupted by various causes and are not sufficiently advanced for publication.

516. Fresh proposals for the reorganisation of the office were submitted in June, but had not been sanctioned at the close of the year. It may be pointed out that with the continual increase in the demands upon the office some corresponding increase in the working power of the establishment is absolutely necessary. The additional power given by the new machinery is already insufficient, and it will be impossible to carry on the work any longer in the state of strain it has been during the past year. The new lithographic machine which has been received during the year will relieve the pressure as far as the colour printing goes, but the additional establishment is also most urgently required to work this machine and enable the general work of the office to be efficiently carried on.*

MAP RECORD AND ISSUE OFFICE.

Personnel.

Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, in charge up to 4th May 1892 and from 1st July 1892.
Captain W. J. Bythell, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 5th May to 30th June 1892.
Mr. A. E. Byrn, Head Assistant.
" H. R. Vallis, Map Curator, and 14 clerks.
" B. M. Wilson, Sub-Assistant Superintendent, 2nd grade, attached.

517. During the year under report the general superintendence of this office has been in the hands of Colonel W. H. Wilkins, S.C., and Captain W. J. Bythell, R.E., respectively.

* Colonel Waterhouse again reports favourably of all his principal assistants, who have zealously met the increased work devolving on them, *viz.*, Mr. H. L. Lepage, Mr. B. Mackenzie, Mr. D. Deas, Mr. E. A. LeFranc, Sergeant Vandyke, and Mr. DePyvah, in the Lithographic, Zincographic and Type Printing sections; Mr. H. Haward, Mr. A. W. Turner, Mr. J. Harrold, Mr. R. George, and Mr. L. Lagnier, in the Photographic sections; also Mr. W. Moore, Store-keeper. Among the junior assistants and apprentices; Messrs. J. Mackenzie, S. U. Ravenscroft, G. A. Le Franc, C. J. Meade, J. T. Meade and P. Michael have worked well and made good progress in their respective duties. In the Lithographic Drawing section, Babu Umbica Churn Mukerji and Munshi Abdul Hamid may be specially noticed among the native draftsmen, but all have worked well. Among the native assistants in the Photographic sections, Mahomed Ismail, Habibul Hossain, Abdul Rahman, Umbica Charan Bhuttacharjee and Preonath Chatterjee, assistant photographers; Azizur Rahman, native engraver, and Aghore Nath Sircar, copperplate printer, have all done their work steadily and well. In the Correspondence and Account sections, Babu Kanai Lal Sen, head clerk and accountant; Babus Gopal Chandra Mukerji, Kedar Nath Ghose, Rajani Kanta Chatterjee and Surjee Kumar Banerjee are all well reported on.

518. The number and value of maps issued during the year are as follows :—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	41,093	41,487
Ditto to India Office, London	7,189	9,018
Ditto to Agents	967	1,448
Ditto to private individuals	8,116	12,999
TOTAL .	57,365	64,952
Cadastral maps to Government officials	133,214	71,127
GRAND TOTAL .	1,90,579	1,36,079

519. There has been a decrease in the number of maps issued, which is principally due to smaller demands from Government officials, but a small increase in their value, as compared with last year's totals which were ₹2,08,484 and ₹1,35,245, respectively.

520. The amount realized from cash sales was ₹22,091, *viz.*, ₹12,999 from private individuals, ₹1,638 from Map Agents, and ₹7,454 from Government officials. Thus the cash receipts exceeded those of the preceding year by ₹9,174 : this is chiefly due to the enforcement of the rule requiring Government officials to pay cash for supplies under the value of ₹50. In the Revenue section, 281 applications were received for extracts from original records of the Revenue Surveys, and 3,487 certified copies of village plans, tracings, and traverses were supplied at a cost of ₹7,291.

521. The details of work done are given in the following statement, and compare favourably with those of the year preceding :—

Details.	Number.
Applications received for maps	5,015
Letters issued in reply	2,881
Cash and credit map sale bills	1,294
Invoices and receipts issued for published map	1,904
Ditto ditto cadastral maps	315
Ditto ditto extracts from original records . . .	281
Packets, parcels, and local despatches	3,173
Ditto received	724
Packages despatched by rail and steamer	431
Ditto received ditto	43
Maps, coloured, for sale and issue	33,176
Ditto for other departments	9,910

A list of the maps and charts published during the year will be found at page 106.*

* Mr. H. R. Vallis has discharged the duties of curator and salesman in a satisfactory manner.

MATHEMATICAL INSTRUMENT OFFICE.

522. For the greater part of the period under report the charge of this office has been held by Lieutenant-Colonel M. W. Rogers, R.E., Assistant Surveyor-General, who also continued to hold the appointment of Patents Secretary. Whilst that officer was absent on privilege leave from 5th May to 23rd June 1892, the charge was held by Colonel W. H. Wilkins, S.C., Assistant Surveyor-General.

Personnel.

Lieutenant-Colonel M. W. Rogers, R.E., Assistant Surveyor-General, in charge up to 4th May and from 24th June 1892.
Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, in charge from 5th May to 23rd June 1892.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument Maker.
„ T. R. Theakston, Officiating Assistant Mathematical Instrument Maker, from 29th October 1891.
198 artificers.

Store Branch.

Mr. M. C. Belletty, Instrument Store-keeper, up to 12th April 1892 and from 1st August 1892.
Mr. W. R. Tulloch, Officiating Instrument Store-keeper, from 12th April up to 31st July 1892.
Babu Woomesh Chunder Chowdhury, Material Store-keeper.
1 packing sircar and 2 packers.

Office Establishment.

Mr. W. Campagnac, Head Clerk, up to 11th April 1892.
„ M. C. Belletty, Officiating Head Clerk, from 12th April up to 31st July 1892.
Mr. W. R. Tulloch, 2nd clerk.
8 clerks and 3 temporary clerks.

523. The figures given in this report refer to the financial year 1891-92, *i.e.*, from 1st April 1891 to 31st March 1892. During this period, 93,661 serviceable instruments valued at R3,85,697 were received into store, and 83,202 instruments valued at R3,16,373 were issued. The number of serviceable instruments in store has thus increased by 10,459 and their value by R69,324. Compared with the figures of the preceding year there is a large increase both in issues and receipts, as shown below :—

	1890-91.	1891-92.	Increase.
Number of instruments received	63,196	93,661	30,465
Value of ditto R	2,59,909	3,85,697	1,25,788
Number of instruments issued	64,203	83,202	18,999
Value of ditto R	2,88,337	3,16,373	28,036

524. The following tabular statement shows the principal sources from which the serviceable instruments were received :—

Sources of Receipt.	No.	Value.
		R
From England on indent	19,402	1,88,462
By purchase in local market	39,316	31,563
Manufactured in workshop	19,640	38,811
Returned to store by public officers	1,083	15,304
From other manufacturing offices	5,000	63
„ repairable stock after repair	6,051	1,05,841
„ other sources	3,169	5,653
TOTAL.	93,661	3 85,697

525. The number and value of the instruments received from England is considerably larger than those of any previous year, and it has been found necessary to increase the indents on England in order to meet the much larger demands from all departments; these become greater each year as work on railways, canals, surveys, etc., increase, and in many kinds of smaller instruments, *e.g.*, compasses, measuring tapes, etc., the supplies asked for are in hundreds where they were in tens a few years ago. The number of instruments purchased in the local markets is nearly double that of last year, but their value remains almost the same. The number of instruments manufactured in

134661

the workshops is almost the same, but their value is about ₹12,000 more. As explained in last year's report, the amount of these manufactures depends on the number of men who can be spared from the repairs work; the class and value of the instruments manufactured will be found in Table C in the appendix.

526. The number of instruments taken from the repairable stock and rendered serviceable for issue is considerably greater both in number and value than last year, and it is satisfactory to note that this increased out-turn has been accomplished without any decrease in the amount of current repairs. During the year, the office received 5,912 repairable instruments valued at ₹75,365, compared with 3,668 instruments valued at ₹60,784 in last year. The total issues from the repairable stock were 6,051 valued at ₹68,329; these were repaired in the workshops at a cost of ₹37,512, and transferred at the enhanced value to the serviceable stock. The repairable stock has thus been diminished by 139 instruments and increased in value by ₹7,036. It may therefore be considered that there has been no increasing accumulation of repairable instruments, but the results of the last few years show that the increase made to the establishment some years ago barely suffices to prevent the accumulation of repairable instruments, and is unable to diminish their number.

527. The conversion of old pattern theodolites and levels alluded to in paragraph 475 of last year's report has been continued, and in the financial year under report, 11 theodolites and 36 levels were made into serviceable instruments and issued, at a total value of ₹10,005; these instruments in their previous condition were practically worth nothing.

528. During the year, the number of indents supplied has greatly exceeded those of any previous year; this being in some measure due to the large requirements of the Meteorological Department mentioned in paragraph 476 of last year's report. These requirements have been all supplied, and only the current demand for meteorological instruments has now to be met.

529. Large indents for compasses and scales have been received from the Governments of the Central Provinces and North-Western Provinces, which have been duly supplied. The Madras Revenue Survey has again indented on the office for a very large number of measuring chains, etc.

530. The work of altering the service heliographs to agree with the new sealed pattern has continued during the year, and in addition, the Ordnance Department sent a number of binoculars to be altered so as to render the distance between the eyes adjustable.

531. The payments in cash for charges under ₹50 alluded to in paragraph 478 of the last report continue to increase, and in order to meet the extra work entailed by this procedure, as well as by the general expansion of the work of the office, it has been found necessary to employ extra clerks and pay them from the grant for contingent establishment, whereby the amount available for the workshop has been diminished. Table A (in the appendix) shows the amount of debits against various offices and departments for instruments supplied and for work done. It also exhibits the credits for all instruments and materials returned into store. The value of the issues and repairs executed on book debit was ₹3,08,169, being ₹24,000 in excess of last year; this amount includes the value of instruments purchased with the extra-departmental grant of ₹40,000. The credits for instruments returned into store amounted to ₹93,145, which is about ₹9,000 in excess of last year. The cash sales were ₹23,137, against ₹14,871 last year, and ₹10,203 in 1889-90. It will thus be seen that the cash sales have been more than doubled within the last two years, which, as already mentioned, has greatly increased the clerical labour of the office.

532. The number of principal instruments repaired in the workshop is 2,284, which is nearly the same as last year: the total number of instruments of all kinds repaired amounts to 3,691 compared with 3,565 in 1890-91.

533. It will thus be seen that there is a steady increase in the demands on the Mathematical Instrument Office and that its work is continually becoming greater. The Survey of India still continues the largest customer, having taken instruments valued at ₹82,000 or a little under one-fourth of the total issues, but several provinces, notably Burma, which has taken instruments valued at ₹50,000, are also large indentors.

534. During the year, a surveyor has been deputed to take stock of the instruments, and this work has been completed and his returns are now being

checked by the Assistant Mathematical Instrument Maker and another surveyor. Stock-taking is an extremely difficult and troublesome business, and is complicated by the necessity of continuing the issues and receipts during the considerable time it takes to complete it. When finished, a detailed report will be submitted, but as far as the results have been checked, the state of the stock is very satisfactory.

535. The profit and loss account of the workshop will be found in the appendix, the result of the operations showing an apparent profit of ₹18,191. Of this quite half is due to the apparent loss shown in the account for last year and explained in paragraph 484 of the last report. The resulting net profit of about ₹9,000 is, however, too large and points to rates being too high. The attention of the Mathematical Instrument Maker has been directed to this point, and it is hoped that in the current year the account will more nearly balance.*

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

536. The work of the office is divided into the following sections:—

(1) Correspondence, Accounts, and Records.
(2) Computing.
(3) Type-printing.
(4) Drawing and compiling.
(5) Photozincography.
(6) Solar Photography.
(7) Miscellaneous.

537. The principal work is the final reduction and publication of the operations of the trigonometrical survey, and to the carrying out of this, each of the first five sections mentioned above contributes. The office has to deal with the principal chains of triangulation spread over the whole of India and the secondary triangulation executed in connection therewith; the astronomical observations for the determinations of azimuth and of latitude and electro-telegraphic determinations of the differences of longitude; also with spirit-levelling operations and tidal observations.

Personnel.

Colonel G. Strahan, R.E., Deputy Surveyor-General, in charge Trigonometrical Branch.
Captain S. G. Burrard, R.E., Officiating Deputy Superintendent, 1st grade, in charge Computing Party, from 3rd May to 7th August 1892.
Mr. J. Eccles, M.A., Officiating Deputy Superintendent, 1st grade, in charge Computing Party, up to 3rd May 1892, and from 7th August 1892.

(1) Correspondence, Accounts, and Records.

Mr. F. A. D'Rozario, Head Clerk, and four writers.

(2) Computing.

Mr. H. W. Peychers, Extra Assistant Superintendent, 2nd grade.
Mr. L. J. Pocock, Extra Assistant Superintendent, 2nd grade, up to 17th July 1892.
Mr. A. Christie, Extra Assistant Superintendent, 2nd grade, from 1st May 1892.
Mr. H. G. Shaw, Sub-Assistant Superintendent, 3rd grade, up to 30th September 1892.
Munshi Rahmutulla, Sub-Assistant Superintendent, 3rd grade up to 30th September 1892.
Babu Kali Mohan Ghose, Senior Computer.
Babu Kali Kumar Chatterji, Computer.
Babu Amba Parshad, Computer, and 31 other permanent and temporary computers, record and account-keepers, librarian and writer.

(3) Type-printing.

Mr. B. V. Hughes, Printer, 20 Compositors and temporary hands.

(4) Drawing and Compiling.

Mr. C. H. McA'Fee, Extra Assistant-Superintendent, 3rd grade, 5 draftsmen, 1 sub-surveyor, and 11 assistant and apprentice draftsmen.

(5) Photozincography.

Mr. S. Manuel, Assistant Zinco grapher, 2 assistant photographers, 2 drafts men, and 1 map-keeper.

(6) Solar Photography.

Mr. C. F. Guthrie, Assistant Solar Photographer.

538. The reduction of the tidal observations is made in the field party office; it is only in the compilation and publication of the results to be embodied

* Colonel Rogers reports that Mr. T. Bolton performed the duties of Mathematical Instrument Maker with his usual zeal and ability, and that he has every reason to be satisfied with the energy and intelligence with which he has worked. Mr. Marshall, the Assistant Mathematical Instrument Maker, was absent on furlough during the year, and his place was very satisfactorily filled by Mr. T. R. Theakston, who was sent out by the Secretary of State for the second time to officiate in Mr. Marshall's place. On the termination of his appointment he has obtained a somewhat similar appointment in the Telegraph Department. Mr. Theakston is a promising officer and is well reported on by Mr. Bolton.

The Correspondence and Store Branch under Messrs. Campagnac, Belletty and Tulloch have worked well and satisfactorily, and these officers report favourably of all their subordinates.

in one of the series of professional volumes that this office is concerned. The calculations of observations for latitude, longitude, azimuth, etc., taken by various explorers are also performed in this office, and of late years a good deal of work has been done in this respect, not only in connection with explorations carried out by the Survey Department, but also by officers of other departments.

539. The drawing and compiling sections and the photo-zincographic section, although existing as auxiliaries to the computing section, for the publication of maps, charts, etc., required to illustrate the operations of the trigonometrical survey, have besides been engaged with other work; the former with the compilation and publication of exploration maps, charts of levels determined by railway and canal officers, and other miscellaneous maps; and the latter with a very considerable amount of work for the Forest Department, and for the Quarter Master General's Department.

540 The solar photography has been continued as usual; the work was started in 1877 at the request of the Industry, Science and Art Department, conveyed through the Secretary of State. At first the pictures were 4 inches in diameter, but later on they were increased to 8 and 12 inches in diameter. The 12-inch pictures are only taken when special features appear.

541. The work of the miscellaneous section is chiefly in looking after the depôt of instruments and stores appertaining to the trigonometrical branch of the survey, and of a special equipment for mobilisation which has now to be maintained on a large scale. It also includes the training of officers and explorers both of this and other departments, and certain scientific investigations which have to be made from time to time.

542. During the year under report the office has made very considerable progress towards printing Volume XV of the *Account of the Operations, etc.*, which is to contain the results of the electro-telegraphic differences of longitude, in continuation of those published in Volumes IX and X of the same series, as well as the final reduction of all the longitude materials collected up to date: the work is so well advanced that it is expected to be completed in the early part of next year. The volume to contain the Tidal observations has also been in hand, and some progress has been made, chiefly with the compilation of the introductory chapters.

543. During the year the synoptical volumes of the several chains of principal triangles, which are required by local officials and detail surveyors, have made rapid progress. Five of the Southern Trigon and five of the South-West Quadrilateral were occupying special attention. Of these, two have been bound and issued, as well as the three reported last year to be in the hands of the binder; three are nearly finished and expected to be ready for issue in the early part of next year; three others are very considerably advanced, and some progress has also been made with the remaining two. The pamphlet of spirit levelled-heights No. 6, Bombay Presidency, and a reprint of an exploration report, were printed, bound, and issued.

544. In addition to the regular work of the office, assistance was afforded to the field parties, etc., as follows:—Two computers were lent for seven weeks to the Astronomical parties for the completion of the latitude calculations of season 1890-91 and of the electro-telegraphic longitude work of season 1891-92, and two others were engaged for two weeks for the Quarter Master General's Department in reducing astronomical and other observations taken by Captain Bower in his journey through Tibet.

545. The work done by the drawing and compiling section and by the photo-zincographic section will be found detailed in the appendix.

546. Photographs of the sun have been taken throughout the year on all days that the sun was visible, and the negatives have seen sent to England to the Solar Physics Committee at South Kensington. The results of these photographs are included in the yearly volumes of the Greenwich observations.

547. Meteorological observations, including the record of the deep sunk thermometers, have continued to be taken as heretofore; the sunshine record has also been maintained. The preservation and issue of instruments have been supervised as usual, and the special equipment referred to above kept in an efficient state. One set of examination papers for the Junior Division was prepared and looked over, and three officers of the same division have received special instructions in the use of instruments appertaining to the scientific work of this branch. Further details of the work done will be found in the appendix.

548. The work in the various sections has made very satisfactory progress, and gives evidence of skilful administration, especially with the final reduction and publication of the trigonometrical records of past years. With the increased means placed at the disposal of the computing section a very considerable progress has been made.*

III.—DRAWING OFFICE, SIMLA.

549. The charge of this office was resumed by Colonel Holdich on his return from furlough on the 15th October, 1891. On his proceeding to the field as officer in charge of No. 15 Party on the 17th November, 1891, the charge devolved nominally upon the Deputy Quarter Master General, Intelligence Branch, until the return of Colonel Holdich from the field on the 27th April, 1892. Practically, however, Mr. G. W. E. Atkinson had almost entire control of the work during this period, and conducted the office business with his usual care and skill. During the recess season Colonel Holdich remained personally in charge, except for a short period whilst he was visiting the head-quarters of No. 15 Party at Quetta, when Mr. Atkinson again assumed the superintendence.

Personnel

Colonel T. H. Holdich, R.E., Superintendent, 1st grade, in charge.
Mr. G. W. E. Atkinson, Extra Assistant Superintendent, 1st grade.
„ W. J. Cornelius, Extra Assistant Superintendent, 4th grade.
„ A. Kitchen, Sub-Assistant Superintendent, 1st grade.
„ F. E. Warde, Sub-Assistant Superintendent, 2nd grade.
„ F. Rozario, Surveyor.
„ H. Sindon, Draftsman.
Munshi Jafir Khan, Draftsman.
Mr. W. Manly, Draftsman, and four other draftsmen.

550. The sheets of the South-West Asia series (comprising Western Persia) and of the North-West Trans-Frontier series on the scale of 8 miles =1 inch have furnished the office with the principal work of the season. The South-West Asia series is now completed in its first edition. The only recent geographical information which has not as yet been compiled into these maps, is part of that obtained by Captain Vaughan, whose work affects so many sheets that have only just been published that it is impossible at present to revise all of them. Captain Vaughan's reconnaissance has however been published separately. As regards the North-West Trans-Frontier series on the scale of 8 miles=1 inch, about half of it may be said to be complete. The maps are progressing fairly and are level with military requirements in their rate of publication. In addition to the standard sheets of the survey, a very large amount of miscellaneous drawing has been completed to meet special demands and other maps have been compiled. Under this head, too, are included the new edition of the map of Turkestan (the revision of which well-known map has required a great deal of laborious attention) and the compilation of Captain Bower's route traverse through Tibet, which was practically carried out in the field by Atma Ram, a native employé of the Drawing Office, and is perhaps the chief geographical contribution of the year. The Turkestan sheets are incomplete and still afford room for revision and improvement: every effort will be made to complete this edition at an early date.

551. Colonel Holdich draws attention to the services of Atma Ram, who is considered to have earned special commendation. This sub-surveyor volunteered to accompany Captain Bower on his most adventurous journey through Tibet and has brought back an unbroken traverse of 2,100 miles, besides a large amount of useful information. This is perhaps hardly within the sphere of Drawing Office duties, but this untried and untrained surveyor left this office on exploration duty and returned to it again, and thus his most excellent record can hardly be included elsewhere. A narrative report of his journey will be found in the appendix. He is now attached to the Baluchistan party.†

* Mr. Eccles reports very highly of his assistants, making special mention of Messrs. Peychers, McA'Fee, Hughes, Manuel, and Guthrie, who stand at the head of their respective sections; also of Messrs. Pocock, Christie, and Shaw.

He also bears testimony to the good work of the computers.

The Deputy Surveyor-General records his satisfaction with the work of Mr. D'Rozario, the head clerk, and Babu Hira Singh, the second clerk of his office.

† Colonel Holdich states that, with one exception, his assistants, both European and native, worked most satisfactorily. Of Mr. Atkinson he writes: "I have nothing to add to the excellent report of his services made by Captain Wahab, except my entire concurrence in the views which he expressed in the last year's report as to Mr. Atkinson's ability and efficiency." Messrs. Cornelius and Kitchen are also specially mentioned among the European staff, and the native assistants generally are said to have worked well.

LIST OF MAPS AND CHARTS PUBLISHED DURING THE YEAR 1891-92.

Title.	Scale.	Number of Sheets.	Remarks.
Atlas of India.	In. M.		
Sheets Nos. 40, 42, 59, 74, 94, 114 and 115	1=4	7	With additions to 1891.
Sheet No. 111	1=4	1	With additions to 1890.
Quarter sheets Nos. 22N.E.; 35S.W.; 39N.E. and 114S.W.	1=4	4	
Quarter sheet No. 105S.E.	1=4	1	With additions to 1891.
Quarter sheet No. 130S.E.	1=4	1	With additions to 1890.
General Maps.			
Afghanistan	1=24	2	With additions to railways to March 1892.
India	1=64	4	With additions to railways to January 1891.
India	1=96	1	2nd edition.
India	1=256	1	With additions to railways to 1890.
Provincial Maps.			
Western Bengal	1=8	10	With additions and corrections to boundaries and railways to 1891.
Eastern Bengal, sheets Nos. 11, 12, 13 and 16	1=8	4	With additions and corrections to boundaries and railways to 1891.
Eastern Bengal, sheet No. 14	1=8	1	With additions and corrections to March 1892.
Bengal, Behar, Orissa, and Chota Nagpur	1=16	2	With additions and corrections to railways and boundaries to August 1891.
Central Provinces	1=16	2	With additions to 1891 (engraved).
N.-W. Provinces and Oudh	1=16	4	3rd edition.
Divisional Maps.			
Gorakhpur and Benares (N.-W. P.)	1=4	3	
Gorakhpur (N.-W. P.)	1=4	2	Corrected to 31st December 1891.
Kumaon (N.-W. P.)	1=4	4	Corrected to 31st January 1891.
Rohilkhand (N.-W. P.)	1=4	4	Corrected to January 1891.
Rajshahi (Bengal)	1=8	1	
District Maps.			
Hooghly and Howrah (Bengal), sheets Nos. 1 to 5	1=1	4	With additions and corrections to boundaries and railways to February 1892.
24-Pergunnahs (Bengal), sheet No. 5	1=1	1	With additions to railways to April 1892.
Basti (N.-W. P.), 1883—88	1=2	4	
Benares (N.-W. P.), 1882—84	1=2	3	
Patna (Bengal)	1=4	1	With additions and corrections to July 1891.
Shahabad (Bengal)	1=4	1	With additions and corrections to boundaries, roads and canals to December 1891.

Title.	Scale.	Number of Sheets.	Remarks.
DISTRICT MAPS—*contd.*	In. M.		
Sunderbuns (Bengal)	1=4	2	With additions and corrections to 1891.
Sylhet (Assam)	1=4	1	With additions and corrections to October 1891.
STANDARD MAPS.			
Bengal.			
Sheets Nos. 1, 2, 5, 6, 343, 363 and 374	1=1	7	
Bombay.			
Sheets Nos. 279N.E., 308S.W. and 309N.W.	2=1	3	
Sheets Nos. 185, 186, 255 and 330	1=1	4	
Burma (Lower).			
Sheets Nos. 225 S.E./2, 272 S.W./3 and 273 N.W./1 N.W./3, S.W./1, and S.W./3	4=1	6	
Sheet No. 181	1=1	1	2nd edition.
Sheets Nos. 227, 569, 567 and portion of 583 (in one), and 568 and portion of 584 (in one)	1=1	4	
Central India and Rajputana.			
Sheets Nos. 430, 467 and 478	1=1	3	
Central Provinces.			
Sheets Nos. 24 N.E./1, N.W./2, S.E./3, S.W./1; 25 N.E./1, N.E./2, N.E./3, N.W./1, N.W./2, S.E./2 and S.W./2	4=1	11	
Sheets Nos. 31 and 82	1=1	2	
Madras.			
Sheet No. 151	1=1	1	
N.-W. Provinces and Oudh.			
Sheets Nos. 3, 11, 12 and 114	1=1	4	
Sheet No. 100	1=1	1	With additions and corrections to February 1892.
Punjab.			
Sheets Nos. 116, 117, 118, 142, 143, 145, 168, 169, 211, 212, 223, 224, 234, 235, 236, 237, 238, 247, 248, 254, 255, 283, 291, 292, and 316	1=1	25	
Sheet No. 294	1=1	1	2nd edition.
North-Eastern Frontier Series.			
Sheet No. 15 N. E.	1=4	1	2nd edition.
Sheet No. 15 S. E.	1=4	1	4th edition.
Sheet No. 22 S. W.	1=4	1	2nd edition.
Sheet No. 23 N. W.	1=4	1	5th edition.
Sheet No. 23 S. W.	1=4	1	4th edition.
Sheet No. 23 S. W.	1=4	1	5th edition.
Sheet No. 23 S. W.	1=4	1	6th edition.
Sheet No. 15	1=8	1	2nd edition.
Sheet No. 22	1=8	1	3rd edition.
South-Eastern Frontier Series.			
Sheet No. 1 N. E.	1=4	1	4th edition.
Sheet No. 1 N. W.	1=4	1	1st edition.

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps—*contd.*			
South-Eastern Frontier Series—contd.	In. M.		
Sheet No. 1 N. W.	1=4	1	2nd edition.
Sheet No. 1 S. E.	1=4	1	5th edition.
Sheet No. 2 S. E.	1=4	1	4th edition.
Sheet No. 3 N. E.	1=4	1	3rd edition.
Sheet No. 4 N. E.	1=4	1	3rd edition.
Sheet No. 4 N. W.	1=4	1	4th edition.
Sheet No. 4 S. W.	1=4	1	5th edition.
Sheet No. 4 S. E.	1=4	1	3rd edition.
Sheet No. 5 S. W.	1=4	1	5th edition.
Sheet No. 1	1=8	1	3rd edition.
Plans of Cities and Cantonments.			
Kamptee, 1890	8=1	2	
Satara	8=1	2	With additions and corrections to May 1892.
Dinapore	6=1	2	With additions and corrections to July 1892.
Calcutta	3=1	1	2nd edition.
Index Maps.			
Sheets of the Simla and Kalka Road Survey	1=2	1	With addition of railway.
Standard sheets of Bengal	...	1	Corrected to February 1892.
Statistical Maps.			
India, illustrating the systems of Railway	1=96	1	Corrected to 30th September 1891.
India, showing Telegraphs	1=96	1	Corrected to 31st March 1892.
Administration Report Maps.			
Gurjat States (Chota Nagpur)	1=16	1	
Berar (skeleton)	1=24	1	
Punjab and surrounding countries (skeleton)	1=32	1	With additions and corrections to railways to June 1891.
Upper Burma	1=64	1	With additions and corrections to March 1892.
Bombay Presidency	1=80	1	With additions and corrections to 1891.
Central India Agency	1=80	1	With additions and corrections to 1891.
N.-W. Provinces and Oudh	1=80	1	
Punjab	1=80	1	
Rajputana Agency	1=80	1	With additions and corrections to 1891.
India (Railways)	1=96	1	Corrected to 31st March 1892.
Miscellaneous Maps.			
Kalakad Reserved Forest, Nangunere taluk, Tinnevelly District, Madras	4=1	6	
Papanasam Reserved Forest, Ambasamudram taluk, Tinnevelly District, Madras, 1890—92	4=1	7	
Terku Viravanallur Reserved Forest, Ambasamudram taluk, Tinnevelly District, Madras, 1890-91	4=1	1	
Muragumalai Reserved Forest, Periyakolam taluk, Madura District, Madras	4=1	1	
Palni Hills, Southern Slopes, East Reserved Forest, Palni taluk, Madura District, Madras	4=1	2	
Pambukallar and Kokkuparaikallar Reserved Forests, Palni taluk, Madura District, Madras	4=1	1	
Palni Hills, Northern Slopes, East Reserved Forest, Palni Taluk, Madura District, Madras	4=1	4	
Palni Hills, Northern Slopes, West Reserved Forest, Palni taluk, Madura District, Madras	4=1	4	

Title.	Scale.	Number of Sheets.	Remarks.
Miscellaneous Maps—*contd.*	In. M.		
Senkatampati Reserved Forest, Dindigal Taluk, Madura District, Madras	4=1	1	
Kadonakurichi Reserved Forest, Dindigal Taluk, Madura District, Madras	4=1	1	
Kudiraimalai Teri Reserved Lands, Tenkarai Taluk, Tinnevelly District, Madras	4=1	2	
Hazara Expedition, 1891, parts of Hazara District and Indus Valley	2=1	2	
Portion of coal-field tract, Upper Chindwin District, 1891-92	1=1	1	
Reconnaissance survey of the route followed by Lieutenant Daly's party towards the China Frontier, 1890-91	1=4	1	
Astor and Gilgit with surrounding country	1=4	1	
Ulwar State (Rajputana)	1=4	1	
Rajputana Topographical Survey Degree, Sheet No. IV, parts of Jeypur, Jodhpur, Kishengarh and Tonk States	1=4	1	With addition of railways to March 1892.
Map of Upper Irrawaddy River to illustrate the report on Frontier Expedition of 1890-91	1=8	2	
Map to accompany preliminary report on the Chin-Lushai country, December 1892	1=8	1	
Triangulation Charts.			
Ganjam and Orissa Topographical Survey, portions of Raipur, Bilaspur, etc., 1863-64	1=4	1	
Lushai Survey Expeditionary Force, 1889-90	1=4	1	
North-East Longitudinal Series, G. T. Survey	1=4	7	

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

APPENDIX.

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

UPPER BURMA TRIANGULATION.

Statement of the out-turn of work executed by No. 24 Party during Season 1891-1892.

Description of details.	
Number of principal stations newly fixed	14
„ „ figures completed	7
Length of principal series in miles completed	196
„ approximate series in miles in advance	88
Area of principal triangulation in square miles	4,300
Average triangular error in seconds	0″·62
„ probable error of angles in seconds	0″·32
Astronomical azimuths of verification	3
Number of principal stations selected in advance	10
„ platforms constructed for principal stations	12
„ principal stations placed under official protection	12
„ principal stations the elements of which have been computed	14
Area embraced by the triangulation to points exterior to principal triangulation in square miles	900
Number of points fixed by intersection but not visited	7
„ stations and points the heights of which have been determined	21
„ miles of rays and pathways cleared	20
„ preliminary charts of triangulation	2
„ hill-tops cleared of forest or jungle	10
Secondary Series—Approximate work in miles in advance	96
„ „ Number of triangles completed	1
„ „ „ of points fixed by intersection	3

BALUCHISTAN.

ETHNOGRAPHIC AND HISTORICAL NOTES ON MAKRAN.

By COLONEL T. H. HOLDICH, R.E., *Superintendent, 1st grade, in charge No. 15 Party, Season 1891-92.*

The progress of the survey of Southern Baluchistan and Makrán has led to some interesting discoveries in connection with the earlier periods of occupation of that country which may possibly assist to throw light on the ethnography of its present inhabitants and elucidate something of their history.

Doubtless very much confusion prevails in the existing official classification of the tribes of Southern Baluchistan, especially in their sub-divisional sections; and although it is impossible to trace out the exact degrees of relationship that exist amongst them with anything like accuracy in the absence of all local historical record, it may be possible to re-arrange some of the larger tribal features with an approach to probability. The general effect of all enquiries in the inter-tribal relation of the Baluchistanis (*i.e.*, the inhabitants of Baluchistan in contra-distinction to the Baluchis) has been to prove that they are most irregular and indefinite. To find a parallel, we must take the Scottish highland clans of some three centuries ago, which indeed they very much resemble. The larger and more advanced communities, as they rise to ruling positions, absorb the dependent and mixed population around them. The slaves and the half-castes, with some of the weaker sections of other clans who require the protection of a strong arm in the general fight for existence, have cast in their lot with the winning powers, and assumed a genealogy which does not belong to them; and thus a few generations have been sufficient in some cases to establish the position of a powerful border tribe which had no previous existence. It is impossible, for instance, to suppose that all who call themselves Gichkis can be true descendants from that Punjabi adventurer who originated that tribe in the early part of the 17th century. Similarly with the Kambaranis (the ruling tribe of Kalat), amongst whom it would probably be as difficult to pick out a true Kambarani as to select a veritable Mackenzie from amongst the people of that name who form the bulk of the population of three counties of Scotland.

A certain amount of fresh ethnographical information has been obtained which may serve to define the successive waves of immigration into Makrán, and, when taken in connection with recent discoveries of strangely constructed sepulchral monuments, and with the relics of a forgotten commercial age which are found scattered along the coast may throw some light on eastern mediæval history.

It is indeed chiefly in unravelling the commercial history of Makrán that the interest of enquiry lies, for there are some who look for a fresh impetus and fresh direction to be given to the trade of Eastern Persia and Western Afghanistan by the establishment of railway communication between Sistán and the coast, or between Sistán and India; and a study of the commercial past of a country, a past so ancient in this case as to be utterly lost in the mists of antiquity, cannot but be useful in forecasting future possibilities.

What the former extent of the trade that passed through Makrán previous to the discovery of the Cape route to India may have been can only be estimated by the extent of the ruins that are now visible of its great coast ports. It must have been at its zenith in the days when Tiz (near Chahbar in Persian Makrán) and Pasni were large and flourishing cities. These were evidently the days when Siráf (the modern Tahiri, but still known by the old name) commanded the trade of the Persian Gulf, and the Arabs kept the seas. The extraordinary nature of the vast cemeteries at Siráf and Tiz, and the peculiar construction of the tombs, renders it certain that the same people lived and traded in both places. Of Siráf we learn a little from the records of Marco Polo. Of Tiz we have lately learned something by examination of its ruins, and we have found, as it were, traces of successive strata of occupation; Persian, Arabic, Venetian, then Arabic again, and finally, on the submit of this débris of centuries, a few fisherfolk living in mat-built huts under the shade of gigantic trees planted by a people of whom they know nothing.

The earliest written history that exists of Southern Baluchistan and Makrán is said to be that of Herodotus, who describes those countries as included in parts of the fourteenth and seventeenth Persian satrapies four centuries and a half B.C., and which mentions the names of tribes whose descendants can be traced locally to this day. But Makrán possesses an earlier unwritten history than that of Herodotus, and we must go back probably to 2,000 years B.C. to find the origin of those remarkable '*dambs*' or rough stone-built tombs which exist in many parts of the country, examples of which are described by Colonel Mockler, who visited them in 1876. Colonel Mockler was inclined to consider them Scythian, possibly monuments of the ancestors of those Brahui tribes who now occupy Eastern Makrán; but since he wrote we have the results of Mr. Bent's remarkable discoveries in the Persian Gulf, and his identification of the Bahrein Islands with the early home of the Phœnicians, the Tyros of Strabo and Pliny, the Sidodona of Nearchus, possibly the Tyre and Sidon of Biblical record, the centre of that vast maritime trade area from which Solomon's ships collected their gold and ivory, peacocks and apes. That a people who traded as far as the Phœnicians, who colonised as no people have colonised since, except the English, who carried their religious symbolism as far west as Ireland, where it is traced to this day, who, as Druids, erected Stone-henge, and who left

no land unexplored that was within navigable reach, should have neglected the coasts of Persia and Makrán is most improbable; and there is, I think, quite sufficient family likeness between the '*dambs*' of Makrán and the tombs opened by Bent and Durand, to warrant a conjecture that they may belong to the same people, though perhaps of a different age. It is indeed propably to the Phœnicians that we owe the name Beluchistan, the land of Belus, Baal or Bel, their sun-god. The Bahrein tombs (see *R. G. S. Journal* for January 1890) consisted of two chambers, upper and lower; the upper one being covered with rough unhewn limestone slabs, and containing fragments of ornaments and other properties of the deceased, even to the bones of domestic animals. The lower chamber was the real tomb. It was entirely coated with cement, and the ground of it was covered with a "thin brown earth somewhat resembling snuff." This was supposed by Mr. Bent to be the remains of decayed drapery, and in this deposit human bones were found. The whole structure was covered with a mound of earth through which was a passage to the tomb, and the mound preserved the tomb, securing it from the destroying influences of centuries. It was Captain (now Sir Edward) Durand who first disturbed the repose of the people who had been sleeping their quiet sleep in these tombs for about 4,000 years, and Mr. Bent followed, and made exhaustive examination of them. The '*dambs*' of Western Makrán and of the country south of Kharán, where they are very extensive, have no earth-covering to protect them. Those described by Colonel Mockler in his contribution to the Royal Asiatic Society, entitled "On ruins in Makrán" in January 1877, are built on the hard sloping surface of a shelving hill side, and he does not suggest the Phœnician double storey; but the condition of the interior strongly points to the possibility of such a construction, and suggests that the slope of the hill may have been utilized in support of one end of the partition, whilst the position of the doors (facing west, so that the head of the deceased lay eastward); the traces of cement covering the walls completely; the brown snuff-like deposit; the occasional remains of shell ornaments and the few bones, are all indications that those most ancient mariners, the Puni, were the builders of these sepulchres, although the want of earth-covering has led to the more speedy dissolution of the relics. Mr. Bent notes that all the Bahrein tombs were not earth-covered; he states that "miles away, in the direction of Rufaa, we found mounds elevated only a few feet above the level of the desert, and some mere circular heaps of stones. Now, it is a peculiarity of the '*dambs*' of Makrán that where the tombs have subsided, they form "circular heaps of stones." Colonel Mockler says of the '*dambs*' at Damba-koh that "when these '*dambs*,' which are square, fall to ruin, the stones of which they are composed almost invariably form a perfect circle. The lintel of the doorway, or the wall next to it, appears generally to give way first, and the apex of the cone-like roof falls in; the side walls then gradually subside, and eventually all trace (without clearing away the stones very carefully) of the former square shape, or of a doorway, is lost, and a circular ring of stones is formed, with a patch of white clay in the centre."

The Damba-koh monuments.

It is unfortunate that no one observer has as yet visited the Bahrein tombs, the Damba-koh, and the Kharán '*dambs*'; otherwise conjecture might have given way to certainty. There appears to be great probability, to say the least of it, that the origin of them all is the same.

So far it has, I think, been a generally accepted theory that the double-storeyed tomb is a distinctive Phœnician construction, but we have found, in the process of surveying this old world country, a remarkable collection of tombs near Jalk, known locally as the "tombs of the Maliks," built in two storeys and crowned with a cupola. They have been carefully examined by Mr. G. P. Tate, and it seems clear that, whatever may be the prototype of these curious constuctions, they are certainly younger than the '*dambs*' by some thousands of years. These will be described further on; meanwhile, we will follow up from the Damba-koh the first faint indications of the early history of Makrán, indications which, faint as they are, may serve to quicken the inspiration of our modern historians of the Persian Gulf and the Erythræan Sea, and possibly induce an archæologist to turn his attention this way.

Other monuments constructed on Phœnician principles.

The Phœnicians, we know, in later times betook themselves to the less genial but more refreshing climate of the Mediterranean, and entirely forsook the land of their birth. Some of them indeed revisited Makrán in the train of Alexander's army, acting as sutlers and merchants, still retaining a keen eye to the collection of 'myrrh' and 'spikenard.' If we are to believe Arrian, they must have had every reason to congratulate themselves on their intermediate change of climate, for they certainly showed no disposition to remain in the early home of their ancestors. The Alexandrian epoch in Makrán gives us the first solid clue to the character of the people of Makrán (the Mahi-Khurán, or icthyophagi) in the third century B.C. When that great conqueror reluctantly turned his face southward from the Punjab and brought his ships and his armies by the highway of the Indus to the sea, who were the people that he found occupying the country that lay between him and Persia? Who were the *Malli* of the Indus delta, the Oritæ of the Arabius, the Gadrosi, the Arachoti, the Parikanoi and others who barred his progress or swelled his triumphs?

Alexander's epoch in Makrán.

It is curious that after a lapse of 2,300 years we can find representatives for nearly all of them in Southern Baluchistan, and most of them very near where the Greek geographers placed their forefathers.

Identification of tribes mentioned by Greek historians.

The Oritæ, indeed, are not easy to identify. There are no people near the Arabius (if the Arabius has been rightly identified as the Puráli) answering to this Trans-Indus clan. The Hôts of Western Makrán may possibly be their modern representatives, but this conjecture is merely based on the slight similarity of name and the undoubtedly ancient lineage of that tribe. Their change of locality would not be unusual. The bodily transfer of a people from one part of the world to another, which has formed so remarkable a feature in early history from the days of Israel to those of the Mongols, is apt to upset the most ingenious theories of genealogical succession; but we find one guiding rule in India which may generally be trusted in deciding the course of successive waves of occupation in any country. As a rule, the latest arrival will be found to occupy the most productive (and consequently the most attractive) ground, whilst the older residents have been driven, like Kaffirs, Bhils and Gonds, into the most inaccessible wildernesses. The inference indeed is strong that the wild men of the hills are the first owners of the soil. Makrán seems to offer no exception to the rule. Long before the days of Alexander, when Greek settlements were in existence through the length and breadth of high Asia, Makrán had been peopled by successive irruptive hordes from the same unfailing sources in Western and Central Asia that had peopled India, and probably in the same progressive order. First came a Turanian race, possibly the Naga of the earliest Hindu writers. These were displaced by the Aryans. Then followed the nomadic Saka, Sacæ, Saxon, Skythian races from beyond the Hindu Kush. Some of these, in later times, may possibly have formed part of Alexander's army, but they were clearly in occupation of Sistán (Sakastan, according to Latham) and parts of Makrán two centuries before Alexander's time. They have apparently disappeared from Sistán, driven southward by Aryan interlopers, but they are found again under their old names, in the Baluch province of Mushki. In these days the Sakas of Mushki, and the Sakazai, the chief section of the fast diminishing Sajadi clan, all claim to be Brahuis. But the Brahuis are clearly the older Turanian settlers, who have been gradually driven into the more inaccessible and wilder hill districts of the east by Aryan immigration, just as their undoubted Tamil brethren of the Central Provinces and Southern India have been gradually hemmed into the almost unexplored forests of Gondwana and the south; for the Brahuis speak a Dravidian language, and the physical likeness between them and the aboriginal tribes of the Central Provinces is marked enough to any one who has studied them both. Colonel Mockler notices, too, as a curious fact, that there is at least one legend attached to the oldest of the stone monuments in Makrán which is common to the Makráni and the Tamil, who tells the same tale about the monuments in Southern India as the Makráni tells about the Damba-koh. The peculiarity of the legend is such that there can be little doubt about its identity of origin. Another fact pointing to their Turanian extraction is that the chief tribe amongst the Brahuis, indeed the most powerful clan in Southern Baluchistan, is called Mingal, and that Mingal and Mongul are derived from the same Turanian stock, that the two names are in fact identical, is a tradition amongst them which it would be hard to set aside. Possibly, indeed, all Brahuis were originally termed Mingal, and the word Brahui or Ba-rohi, which is a word of Sanscrit origin meaning "hillmen" ('*roh*' being a hill in Pushtu), is a comparatively modern designation. The name appears at least to have been known to the Greek historians, for (according to Dr. Bellew) the word Parikanoi is but a transliteration of the Parakan of Persian and Sanscrit, which has exactly the same meaning, *viz.*, "men of the hills." Thus the Sacæ and the Parikanoi appear to be almost exactly where Alexander found them. The Gadaras too, who gave their name to the country as Gadrosia, are still in their old world haunts in the district of Lus Bela. These Asiatic Ethiopians are said (to quote Dr. Bellew again) to belong to the various Kach, Kaj or Kej tribes, who originated the Kach Gandava and Katch Makrán territorial divisions of Baluchistan. They must not be confounded with the Gadurs, who claim to be Koreish Arabs. The Gadaras may possibly be the Garudas of ancient Sanscrit literature, who were (as eagles) represented as being at constant war with the Nagas (snakes); thus, for aught we know, a Sidi stoker of a P. and O. steamer, who is either a Gadara or a Med, may be able to trace back his descent to the time of Moses. Many of the Sidis are however slaves or half-castes from the coast, and of very doubtful origin.

Sacæ or Saxons.

Brahuis.

Gadaras.

The later Aryan or Tajik stock in Makrán, analogous to the same original strata of society in Afghanistan, is well represented by several tribes, chief of which are the Durzadas. The Durzadas (? Derusiai of Herodotus) speak a pure Persian dialect. They are husbandmen, tillers of the soil, like other Tajiks, and when actually employed as slaves, are called Nakibs. They acknowledge the superiority of the so-called Baluch and Brahui tribes amongst whom they dwell, and in their physical bearing there is strong resemblance to the Tajak of Afghanistan. Closely allied to them are the Dehwars, who, as their name denotes, are likewise husbandmen and cultivators. The Dehwars of Kalat are the people who chiefly arrested the attention of Pottinger; but Mr. Tate, of the Baluchistan Survey, describes in his report a very large tribe indeed in Western Makrán bearing the same name, and numbering some 17 or 18 clans, who consider themselves allied to the Rinds, but who are nevertheless undoubted connections of the Kalat Dehwars whom Pottinger rightly classes as Tajik. The Dehwars and Durzadas are probably all of one common Tajik stock, aboriginal Aryan settlers of later date than the Brahuis.

Tajiks.

Meds.

Amongst the oldest residents in Makrán we must admit the Meds. "They have peculiar religious customs, and are superstitious and immoral." This is the verdict of the official Gazetteer, and it is correct enough only that it is hardly exhaustive. In modern days the Meds are a race of coast fishermen, harmless folk, living in much apparent simplicity in huts made of the Pish palm matting, whose lives are almost amphibious, and whose living is derived entirely from the sea. No sea in the world is probably more prolific than the Arabian Sea. The whole coast of Makrán is impregnated with an atmosphere of fish. Fish dried and salted are stacked at the village ports for exportation to the West Coast of India, where salt duties have interfered with the Home industry. Sharks' fins are exported in tons, chiefly to China, and cuttle fish abound. Every living thing in Makrán lives on fish—men, women, dogs, cats, donkeys, and probably camels. I did not see camels eating fish in Makrán, but I observed that they were trained to that diet on the Arabian coast. It is not difficult to recognize in the Meds the ichthyophagi of Nearchus. But Sir Henry Elliott tells us that the Meds of the Makrán coast once occupied the whole delta of the Indus, and, together with the Jats, the whole Indus Valley; that the Meds may possibly be *Medes;* whilst Lassen states that the Meds and Jats are mentioned in the Mahabharata as Madras and Jartikas, eleven centuries B.C. The Jartikas of the Mahabharata are certainly not to be recognized in the Jata Skythic race, who, we know, displaced the Greeks on the Indus about the same time that, as Goths and Vandals, they surged into Europe. If we apply the theory of looking for the aboriginal race in the most inaccessible regions, we should find the Jadráni of the Jadrán hills, west of Tochi, to be the most likely representative of so remote a people as the Jartika, but an identification of this sort must be purely hypothetical. The Med, there seems good reason to think, represents the Mand or Mandan, who for long centuries disputed with the Jats the possession of the Indus Valley.* They may indeed be the same people as the Mers (Mhairs) and Sir H. Elliott suggests that Mæris, King of Pattala, capital of the Indus delta in Alexander's time, was chief of the Mers, or Meds, or Malli, in the conquest of whose country occurred the stirring episode in which Alexander's life was so narrowly saved by his friends Peucestas and Leonatus. It was the piratical successes of the Meds on the high seas that led to the invasion of Sind by the Arabs in A.D. 705; and some centuries later we find the Arab geographer, Ibn Haukel, writing of the Meds or Mands as being still on the Indus and still holding command of the sea. In the coast fishermen of Makrán, now-a-days, one would hardly recognize the scion of an ancient and famous line of sea-kings who carried piracy and pillage into eastern waters with all the ardour and success of the Danes and Vikings of the west. Into the composition of the Med (said in the "Majmalu-t-tawarik," which gives the first account of them that we possess, to be a descendant of Ham) there doubtless now enters a large admixture of African slave blood. Slavery, as an institution, is happily no longer rampant on the Arabian and Persian coasts. Nevertheless there is still more than a lingering trace of the old slave traffic surviving in these countries; slaves are common enough in every port, and there are at least three villages not far from Chahbar where slaves are bred and reared; neither does it appear quite certain that these slaves are bred and reared solely for the local Persian market.

Bolédis.

Amongst others of the ancient tribes of Baluchistan, traces of whose existence remain to this day, we find the Bolédi mentioned by Ptolemy. The Bolédi, as their name denotes, may possibly be of Assyrian origin, possibly even more anciently connected with the Baal of the Phœnicians than the Bel of the Assyrians. They are stated in the official Gazetteer to be of Arabic origin, and to have dispossessed the ruling Maliks in the 17th century, when they headed what is known as the Baluch confederation. They may indeed have subverted the Kaiani Maliks, but they were undoubtedly the original occupants of the Bolédi valley. They are included amongst Brahuis by Latham, but this seems certainly to be incorrect. Whatever may be their pride of origin and race (and that it is most ancient is indisputable) it has been left to the end of this present century to see the last of the reigning house of Bolédi. There is at present living but one representative of the ruling family of the Bolédis, a lady, named Miriam, who lives on the bounty of the Sultan of Muscat. In the second quarter of the last century the Bolédis were overthrown by the Gichkis, of whom more presently.

Coast configuration in Alexander's time.

Thus we are enabled to trace an outline of the ethnography of Makrán as it existed in Alexander's time, and we see how little it has been affected by subsequent waves of invasion, Arab and Tartar, that have left so deep an impression elsewhere in the history of the East. Three hundred and fifty years B.C. there existed in Makrán, Turanian, Aryan, and Ethiopian tribes, gathered in clans amid the wilderness of low hills and sandy deserts much as they are gathered now. The products of the country then so highly esteemed—the myrrh and spikenard—are still to be found, and the euphorbia of the sandy wastes, and the mangrove of the swamps, are still much as Arrian describes them. Probably no part of Asia has changed so little as have the south-western shores and borders of Makrán. The slow-moving course of the fleet under Nearchus has been traced out by Colonel Mockler from the mouth of the Indus to Sonmiani, Pasni, Gwadur (then called Badara, a flourishing little town, with palms and gardens) and Chahbar, and from thence

* The Mandan are of Jata Skythic origin according to Bellew—the Mada or Medes being Naga.

to the Persian Gulf, with a careful accuracy which places his deductions beyond contention. The great headlands of Pasni and Gwadur have changed little in 2,500 years, and with the exception of the submergence of two islands (Pola and Kerabia), off the east of Gwadur Bay, there is hardly a noticeable point of difference in the broad features of the coast. Another island called Derenbosa has disappeared from the west end of the Gwadur headland, and there is yet another which is even now in process of breaking up off Pasabandar, near Gwadur. But these are comparatively small alterations in the coast configuration, and there is nothing whatever analogous to the enormous geological changes which must almost have reconstituted the climate of High Asia within the same period —changes, some measurable approximation to the extent of which was realized by the scientific officers connected with the Afghan Boundary Commission, and which were referred to by Mr. Howarth at the conclusion of Captain Younghusband's last lecture at the Royal Geographical Society. It is probable that the main rivers have silted and formed deltas for themselves where they were once navigable, and I should be inclined to think that the ruins at Sutkagen Dor, 40 miles to the north-west of Gwadur on the Dasht River, are not ruins of a temple, as suggested by Colonel Mockler, but that they are what local tradition assigns them to be, *i.e.*, the remains of an old ghât, or '*bandar*,' to which boats came up from the sea. It must have been down the Dasht River that Alexander turned to the sea-coast after traversing the long narrow Kej Valley for 150 miles. The Kej Valley, however, must then have been in a far less advanced state of civilization and cultivation than it is at present, and all Southern Baluchistan must have been far more thinly inhabited. Thus far we get a very imperfect, but still far from colourless, view of the Makrán of Alexander. The earliest of the rude stone monuments were there before him, but it is probable that the great dams,' or '*ghorbastas*,' of Panjgur and Kolwah awaited the hands of later builders during the period of Arab occupation. Imperfect as this glimpse of early Makrán may be, it seems that, in parting with the Alexandrian epoch, we lose the clearest light that has ever been thrown on its ethnography. There follows a period of darkest historical confusion for a thousand years or so that filled up the gap between the Greek and Arab invasions, during which we have to account for the advent of the so-called Baluchi into the country; for by a strange irony of fate, the Baluchi of to-day is a comparatively recent arrival in Baluchistan, and has probably little or nothing to say to those Baal worshippers who gave the country its name.

Baluchis.

The three great sections of the inhabitants of Baluchistan who are generally recognized under the term Baluchi are the Rinds, the Naruis, and the Maghzis. The latter are apparently unrepresented in Makrán, and the Rinds and Naruis, who are the two great representative tribes, and have doubtless gathered to themselves a host of minor Khels and clans, now occupy all the fairest and most productive valleys of the country. The Rinds include such well-known tribes as the Rekis, Maris, Bugtis, and Bozdars. The Naruis include Sonjaranis, Rakshanis, Kurds, Mings, Arbabis, and Malikahs, according to local tradition. I cannot say that Survey researches throw much fresh light on the history of those people, although Mr. G. P. Tate has spared no labour to render his account of them as accurate as possible. All of them, Naruis and Rinds alike, delight to consider themselves Khoreish Arabs, and to date their first introduction to the country from the time of the Arab conquests. The Rind tradition of their Syrian extraction is well known. It is to the effect that they were Khoreish Arabs driven from Syria by the persecutions of the Kaliph Yejid at the end of the seventh century A.D. They first settled in Dalgan, and then spread abroad; part of them under Rustom Khan, Chakar, emigrating to the Kachchi, where some of them remained in Shoran, to the north-east of Kalat, whilst others again returned and occupied the country about Dizak and Sib. Pottinger calls them all Turcomans. Latham (the ethnographer) remarks that their language is Jatki, and their appearance 'Indian.' With so much diversity of opinion, and the absence of written record, it would perhaps be safest to accept the evidence of language and appearance, and to assume that they were a part of the great Jata Skythic immigration which superseded the Greek occupation of Baktria and the Indus Valley, and that they occupied Makrán, much in the manner indicated by their traditions at the same time that India and Eastern Europe were inundated by Jat hordes. The Rekis of the desert south of the Helmund (Rekistan) are not mentioned by Pottinger, who wrote early in the present century. They are possibly connected with the Sistáni Shahrekis mentioned by Goldsmith, who considers them as originally emigrants from Western Persia. The Shahrekis were in Sistán centuries ago, together with the Kaiyanis and Sarbandis, but were displaced by Shah Rukh, and emigrated to Hamadan, whence they subsequently returned to Sistán. Whilst it is difficult to set aside the Rind tradition of their Syrian origin, it is impossible to admit that they are Arabs, a tradition which is maintained by the Rekis, as well as the rest of the Rind Family. The Rekis claim to be Rinds, but I consider the claim a doubtful one. They are obviously but recent arrivals in the deserts they now occupy, and they say themselves that they found the monuments and remains of sepulchres near Jalk when they took possession. Some of these monuments are not so very old, as we shall see. Amongst the Rinds, Pottinger classes the Naoshirwanis of Kharán—the most important tribe probably in Southern Baluchistan. This again is obivously incorrect. The Naoshirwanis are Persians, speaking a form of old Persian, and Mr. Tate favours Sir Oliver St. John's view as expressed in his report of the Sistán Boundary Commission, *i.e.*, that they came into Baluchistan from Luristan, whence they were expelled about the time of Shah Abbas.

Rinds.

Naruis.

Of that important section of the Baluchis which is classed under the head Narui very little fresh information is at present forthcoming. Certainly the great Narui tribe does not include all the minor Khels with which it is credited in the official Gazetteer (the Sajidi, for instance), and certainly they do not represent one original horde of immigrants into Baluchistan, but successive waves of a human sea overlapping the northern borders of Makrán, and spreading further and further southwards with the lapse of time. I hardly think that the term Narui is to be traced to Na-rohi, *i. e.*, "*not* men of the hills," or, in other words, 'men of the plains.' This negative form of nomenclature is, to say the least of it, uncommon. The tradition amongst some of the Narui tribes is to the effect that they spread into Dizak and its neighbourhood from the Malik Naro hills. This seems to point to a Sistáni origin, and as we now know that the wide plains of Sarhadd to the south and west of Sekoha are occupied by Naruis, and that they extend north to Kala-Fath on the Helmund, it is, at least, probable that the Makráni Narui is but the result of a natural overflow from the north-west. Their language is early Persian. According to the ethnographer Latham they are Kurds, and it will be observed that Kurds are included as a section of the Narui tribe in the Gazetteer, and that their appearance and manners are Kurdish. They are probably comparatively late arrivals in Makrán. Greek writers do not mention them, and their own traditions support the theory of their recent occupation.

Gichkis.

The Gichkis (the ruling tribe at Kej) again are modern innovators descended from one Mai Sing, a Sikh adventurer, who appeared in Makrán about the beginning of the 17th century. They say they remained Hindoo for three generations and then adopted the faith of the country, or rather they started a sect of their own called Zikari. They are allied to the former ruling race at Kej, the Bolédis, whom they deposed. Another tribe said to be descended from a Syud adventurer is the Duzurgada, a powerful clan in Dizak, of which Dilawur Khan is chief. These are interesting examples of the rise of a people from a single individual and illustrate the process of multiplication that takes place in the strength of a clan due to the gradual absorption of weaker tribal surroundings.

Lassis.

The Lassis of Las Bela (who represent the Lumris, and Gadurs, not to be confounded with the Gadaras) form the Rajput element in Southern Baluchistan, and are the only people who are of ancient Hindu stock. Not much is known about them, although they are so contiguous to the Sind frontier, and further investigation into the history of this old offshoot of Hindu race will be most interesting. It may be noted that they occupy the geographical position assigned to the Oritæ by Arrian.

Dark phase of history.

Between the disappearance of the Greeks and the Arab invasion of Makrán early in the 8th century we have no written record, and there intervenes a dark period of history extending over more than a thousand years. Pottinger seems to think (and with good reason) that in the days of the Greek march through Makrán, the northern part of the province was almost desert and unpopulated. It would certainly seem, on examination of the map, that there is but one route by which the Greek armies could have traversed the country from the eastern border to the Dasht river, and that one includes the long narrow Kej valley which runs at a distance of from 30 to 40 miles from the coast parallel to it. No traditions exist, and no record has been found to mark the event, and the Kej valley can hardly be said to answer to Arrian's description of Gadrosia. The sand hills and deserts which impeded the two months' march from the country of the Oritæ to Pura, the capital of Gadrosia, as described by that historian, are such as would distinguish the Mashkhel desert rather than the now comparatively fertile district of Kolwah.

Arab invasion.

The next certain history of Makrán that we arrive at is that of Ferishta, who tells us that the Arabs overran Sistán and Makrán, and that Sind was conquered by Mahomed Kasim, son-in-law of Hajjij about A.D. 705 to 715, or about the same time that Spain was conquered by the Saracens. It was the piratical successes of the Meds that first led to the invasions, and so uncertain were the Arabs of the routes which led through Makrán to India that they adhered as closely as possible to the coast-line during their advance. There is a very old tradition extant in the valley of the Indus, to the effect that the palm-groves of Dera Ghazi Khan and other Indus districts were due to the date stones that the Arabs flung away on their march. Tradition for once seems to be possible history, for it does not appear that the date palm is indigenous either to Makrán or Sind. Very possibly the source of the chief wealth of Makrán, those date groves which form a distinctive feature that must have changed the whole aspect of the country, were not called into existence till as late as the 8th century A.D. It is true that palms are mentioned as flourishing at Gwadur in the days of Alexander, but it is quite possible that the mass of palm vegetation which is now found in Kolwah and Kej had no existence at that time, and that it owes its origin largely to Arab enterprise. The Arabs have left but little trace of their language either in Sind or Makrán. According to Sir H. Elliott (who quotes Ferishta) they never really colonised in Sind. They did not bring their women with them, as was their fashion elsewhere, and their occupation of the Indus valley terminated with Al Kadir in 1031. A few words applied to the geographical features of the country, such as 'Jebel' and 'Wad' or 'Wadi', still survive, but on the Indus, at any rate, Arabic has disappeared as surely as the Greek

tongue, which the Arabs suppressed. Multan was originally an Arab settlement, and from Multan as a trade centre connection was kept up with the rest of the Mahomedan Empire. Sistán was during these dark centuries a well-cultivated country; Kirman and Makrán were full of Arab settlements, and it is to the Arabs almost certainly that Makrán owes those gigantic public works of stones the '*ghorbastas*,' or dams built across the debouchment of hill streams to secure a head of water for irrigation purposes, or such monumental '*bunds*' as that on the Ras Nuh, at Gwadur, which retained their water-supply. The Arabs were great masons, and the ingenuity with which gigantic slabs of stone are toggled and dovetailed together has never been surpassed by any builders in the world. The Arabs indeed changed the face of Makrán from what it was in Alexander's time to something better than it is at present; and then passed away.

Arabic trade.

This unwritten and untold story of the Arab occupation of Sistán and Makrán is of peculiar interest to us, for it seems probable that it was during those misty centuries that a European connection between India and the East was first introduced.

Dawn of European enterprise in the East.

After the overthrow of the Sassanian dynasty in A.D. 641 at the battle of Nahavind, and Yezdigird's flight to Sistán; through the gradual rise and fall of the power of the Kalifs, until Baghdad was taken by Toghrul Beg in 1255, and Arab supremacy was finally broken; we have to grope about in the mists of mediæval twilight for some faint trace of European adventure in these eastern seas. There is little doubt about its existence. It is probable that even those early days saw the first keels laid for sea-going European ships built after an Arab model. Arabia was then mistress of the eastern seas and her mercantile fleets filled the ocean highways and set the fashion of mercantile exploration to the western world. No one who has studied the shape and make of our earliest ocean-going ships, and has compared them with the 'buggalos' and 'dhows' which dot the Arab and Persian coasts, can fail to detect indications of the origin of our lines for wooden ship-building. Even our nautical terms are many of them Arabic. What else is the derivation of "cutter," dinghy" and "barge"? The prototype of our "*Henry VIII*" and "*Royal Sovereign*" of the 16th century may be seen any day hauled up for repairs on the sands at Muscat or Koweit, even as the Arab prototype may itself be found on the Euphrates, built of 'shesham' and 'pitched within and without' with petroleum. The Arabs occupied Makrán and part of the Persian coast long after the last of the Kalifs had been starved in his treasury at Baghdad, for we have the evidence of Marco Polo, writing about 1290 of the kingdom of Kez Macorán, that "the most part of the people are Saracens. They live by merchandise and industry, for they are professed traders and carry on much traffic by sea and land." The largest and most flourishing port of Kez Macorán in those days was undoubtedly Tiz, near Chahbar, and we now have evidence enough to prove the closeness of the connection between Tiz Siráf (the modern Tahiri), which was then a large trade port on the Persian coast, and was flourishing in an age contemporary with Hormuz. This was at a time when Hormuz was as yet undevastated by the Tartar, and was still on the mainland. The epidemic of Tartar and Turk invasion had set in three centuries before Polo's time, beginning with Mahmud of Ghuzni at the commencement of the 11th century, but Hormuz and Siráf still held their own on the mainland. There was hardly a corner of Persia unvisited by the Moghul even then, and Moghuls held all Asia and Eastern Europe. Kublai was "great Kaan," whilst a Turk, Nasr-udin, ruled at Delhi. The Dravidian kingdoms of Southern India were untouched, but all Northern India was in the hands of the Turk. The greatest avenger of all, Timour, had yet to come. He came in 1387, and his exploits are still the tradition of the country side in Sistán and Makrán. It was probably Timour who finally broke the power of the Arabs in Makrán and on the northern shores of the Persian Gulf.

Origin of the lines of English ships.

Marco Polo's time and previous.

During last winter I visited both Siráf and Tiz. Both places are now but uneven masses of heaped up ruins, spreading over a mile or two of the coast, and shadowed by sandstone or clay cliffs which steeply scarp the sides of the rough unvegetated hills. There is much in the conformation of these hills, and in the nature of the narrow valleys running up from the sea, with their unusual display of mighty and aged shade trees (banyan and peepul), that is common to both places. Especially noticeable is the gigantic cemetery which is formed out of the overshadowing hills. Every yard of these hills is occupied by a grave. There are tiers of them on the hill face, which spread into acres on the hill summit; and they are all alike, whether in Siráf or Tiz—from 3 to 4 feet deep, by about 2 feet wide, and 6 or 7 in length. There is this remarkable feature about them. A ledge is cut about 2 feet from the bottom of the grave, which extends the whole length of one side of it. Thus slabs of rough unhewn stones can rest slantwise, one edge fitting into the angle formed by the bottom and side of the grave on that side opposite the ledge; the other edge resting on the ledge itself, forming a neat little recess beneath, of triangular section, in which the body rests. Above the slabs the grave was apparently filled in with earth (at least we found nothing else), and below the slab were only the bones of a body apparently laid on its side at full length.

Siráf and Tiz.

Earlier explorations in Siráf by Captain Townsend, of the Indo-European telegraph steamer "*Patrick Stewart*," had led to the discovery of a tombstone, of which the inscription was finally deciphered at the British Museum, and which proved beyond doubt the

Arabic character of the settlement, and confirmed Polo's assertion that at the end of the 13th century the occupants of Tiz and Siráf were Saracen. But in Saracenic times we know from Ibn Haukel (writing about 1000 A.D.) that the infidel and the Mussulman traded together, and that trade concessions were occasionally interchanged. "In the middle ages (says Elliott) it was only the power and political influence of the Amalfitans, Venetians, Pisans, and Genoese that were sometimes able to extort from the reluctant Mussulman concessions that were willingly granted by the more easy and indifferent Crusaders and Greeks," and "this intercourse with the Saracens was not merely subject to these formal restrictions, but was strongly and honestly reprobated by sincere believers—and not without reason, when we reflect that some of these traders, *especially the Venetians*, disgraced their honor and their faith by supplying the Egyptian market with Circassian slaves, and even rendered their necessary assistance in driving the Crusaders from Acre." So here we have the Venetians in the field, engaged too in the lucrative pursuit of slave-dealing, as early as the 9th century A.D., and apparently intimately associated with the Arabs in those commercial enterprises which linked the East and West by Persian and Mesopotamian routes, and which existed on a scale the extent of which is very little comprehended at the present day. It is a curious and possibly significant fact that the European nation which possessed command of the great overland trade route on which Sistán and Makrán were not unimportant links, was the first commercial nation in the world so long as it held them. It is true that this was before the discovery of the Cape route to the east, whilst as yet the overland route was the only one known to civilized Europe. But with the new links that are being slowly but certainly forged by means of railways between West and East, the old order of supremacy will as certainly revive. The strength of Makrán may yet again be recognized in that geographical position which for many centuries must have enabled her to command a vast share in the trade of Southern Asia.

Arabic and Venetian trade convention.

It appears, then, to be probable that for four or five centuries, whilst Arabia dominated the East, and Venice was mistress of the Mediterranean, whilst as yet Alexandria was the great emporium of the West, Venetians and Arabs were intimately associated in perhaps the greatest trade confederation of the world. If so, we should expect to find evidences of Arab and Venetian occupation of the coast ports of Persia and Makrán more or less intermixed amongst the relics of the past. In Makrán, at any rate, we do so find them. It has long been known that Venetian ducats passed current amongst the coast people, although I have never actually seen them. In excavating the Miri at Quetta for defensive purposes, some of these ducats were discovered by Sir James Browne, and they are now in the British Museum. It may be interesting to mention here that in the same Miri (a mud mound of volcanic origin, which formed a convenient and commanding position for the principal fort in Quetta), a small bronze statue of Hercules was subsequently unearthed by Captain Mackenzie, R.E., an interesting relic of the march of Craterus through Quetta and Kandahar. During last winter, Mr. G. White, of the Indo-European Telegraph Department, discovered at Tiz a gold Venetian ducat of the same value as those found at Quetta, and with the coin were two or three seals cut in agate and cornelian, apparently representing at least two distinct epochs of Arab occupation, one being comparatively modern, and the others (apparently) in cufic character.* Additional evidence exists in the vast quantity of glass ornaments, and the peculiar pottery which are to be found exposed on the surface of the ground amongst the ruins of the old Makrán cities of Pasni and Tiz after heavy rainfall. This glass has not the filmy glaze of the earliest Egyptian glass. It exists in various forms, none of which are entirely transparent. Occasionally fragments are found encrusted with a secondary glaze of glass of different color: or a glass bangle may be found intertwisted with colored threads; or (prettiest of all) small colored ornaments of crude design are applied to a black or dark colored base. The pottery of Siráf and Tiz is very varied, and none of it of oriental design, as we use that term in India. There is a vast quantity of pale sage green celadon, magnificently glazed with a double glaze (inside and out), and a few fragments of ordinary unglazed clay which have been cast in a mould of most elaborate western ornamentation, the figures of which are in high relief. It might be suggested that all the glass and pottery were trade importations, but this theory is upset (as pointed out by Mr. Lockwood Kipling, of the Lahore Museum) by the discovery of part of a jeweller's mould, and of a small tripod arrangement on which pottery rests during the process of baking. Mr. Kipling is inclined to support my opinion that the glass is far more probably due to Venetian rather than Phœnician artists, and that it is of local manufacture.

Arabic and Venetian relics.

The history of Venetian trade supremacy in the East would be of absorbing interest if it could be efficiently recorded. It must have existed through those centuries during which Asia and most of Europe were convulsed with the gigantic conquests of Turks and Mongols. It must have been uninterruptedly maintained in the high seas and along the coasts that fringed the scenes of savage warfare and almost incredible devastation, with a serenity that has left no local record, and but little trace of its existence. The chequered career of Portugese occupation of this Eastern world was but a passing incident compared to that of the Venetians. Even our three centuries of gradually extending influence in India are less in point of time than the Venetians, if we are to judge by the few indications which are now before us.

* I have been unable to get them deciphered.

The tombs of the Maliks.

Amongst the many relics of bye-gone ages throwing snatches of light into some of the darkest corners of history that have been discovered by our surveyors, not the least curious and instructive are the double-storeyed sepulchres, surmounted with cupolas, which are locally known as the "tombs of the Maliks," at Guachig, near Jalk. I am indebted to Mr. Tate for the illustration and description of these curious buildings. These illustrations explain themselves. It only remains to add that they are built of burnt brick and mud cement. The bricks are flat, about 10 inches square and 2 inches thick. The tiles which cover the buildings are square, about 1 foot to 14 inches. The designs on them (some of which are described as exceedingly quaint) are on relief, scraped out from the surface (so Mr. Tate thinks) with an iron tool. Nur Mahomed Khan, brother of the Sirdar of Mashkhel, says that there are similar tiles at Kala-i-Fath on the Helmund, the ancient capital of the Kaiani kingdom which included Sistán. I cannot say that I recollect seeing any when visiting Kala-i-Fath with the Boundary Commission, but they may exist in the interior of the Fort citadel, into which I did not penetrate. The peculiarity of the tombs consisted in the double chamber, which is evidently a later development of the Phœnician tombs of the Bahrein islands. One very curious similarity between these tombs and those examined by Captain Durand, and subsequently by Mr. Bent, lies on the recesses marked *b-b-b* in Mr. Tate's drawing. In the Royal Geographical Society's "Proceedings" of January 1890 we read that in the upper chamber of the Bahrein tomb there were "at the four corners four recesses, two feet ten inches in depth." This in itself marks a distinct connection between the tombs of Guachig and Bahrein. In the Guachig tombs, however, the sarcophagus is in the upper, not the lower, storey; and it is the lower storey which is filled with the bones of the human dependants of the chief who occupies the upper chamber. Of these bones and the wrappings which cover them Mr. Tate remarks that "the grave-clothes were in fairly good condition, and the same below as above. The bones were exceedingly large and in excellent condition."

There can be little doubt that these structures are what they claim to be, *i.e.*, the "tombs of the Maliks."

Subsequently to the Peshdadi, Kaiani, and Sassanian dynasties which closed with the battle of Nahavind in 61, A.D., Sistán fell under the rule of the Kalifs. To them followed the Ghaznavi dynasty, and finally the rule of Turks and Tartars that carry us down to the end of the 14th century. In 1460 Shah Ismail, Safavi, conquered Khorasan, Sistán, and Makrán, and founded the dynasty which lasted to Nadir Shah's time. The Government of Sistán under the Safavi dynasty was invested in the Kaiani Maliks, who claimed descent from the royal house of Kai. Malik Mahomed, Kaiani, was Prince at the time of the Afghan invasion of Nadir Shah.

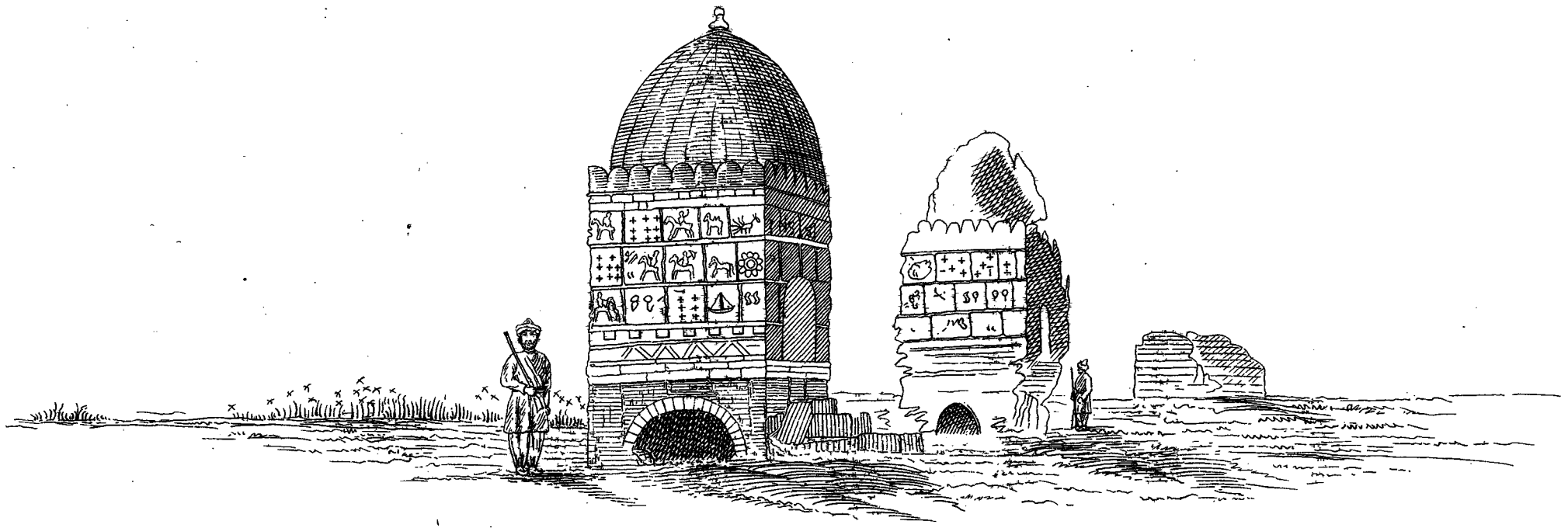
The Kaianis resisted Nadir and his nephew Ali, and finally had to retreat to Koh-i-Khwaja on their defeat. On the death of Nadir (170 years ago) Sistán became Afghan. Thus, these tombs were in all probability built between the years 1460 and 1720, and the excellent state of preservation in which the relics were found is thus accounted for. But what was the connection between the ancient house of Kai and the early Phœnician Gulf traders? Is the adoption of the Phœnician form of sepulture merely imitation, or is it a traditional custom establishing a Phœnician origin for the "Royal house of Kai?" Who, too, were the gigantic race whose bones fill the lower chamber in these tombs? Further examination of this interesting corner of Baluchistan, of which Jalk (known as Gulshán, until its destruction by Nadir Shah's General, Pir Mahomed) is the centre, and, perchance, a translation of the rock-cut inscriptions at Jhalwar, which have hardly yet been examined, may throw new light on this rather obscure subject.

Interest of Saracenic period.

The interest of Makrán history centres, doubtless, in that busy period of Arabian supremacy which extended from early pre-Mahomedan centuries until the Kalifs gave way to the Turks, ere these were again supplanted by the Portuguese after the discovery of the Cape route by Vasco de Gama. It was when the heavy-prowed, square-sterned Arab dhows and buggalos were busy bringing gold and ivory from the African coasts, or carrying spices, spikenard and myrrh, from Makrán, or gold brocades, purple and fine linen from India to the great central marts of Egypt, that in all probability Zimbabwe, the gigantic old world city of Mashonaland, was a flourishing Arab possession. It was then, too, most likely that the "ghorbastas," the great stone 'bunds' of Makrán, were built, for these show the same skill in uncemented masonry as the walls of Zimbabwe; and about the contemporary cities of Tiz and Pasni are found the same extraordinary wealth of relics in celadon, china and Persian pottery as are described by Mr. Bent amongst the African ruins.

Portuguese epoch.

Next in interest comes the period of Portuguese supremacy. It is true that there is little evidence that the Portuguese actually occupied any part of Makrán. From Colonel Miles' most excellent history of the Portuguese occupation of the Gulf we learn that in 1580 when the Portuguese Commander Almeyda was sent from Hormuz to destroy the Turkish fleet under Ali Beg, who had just sacked Muscat, he employed his time in looting Pasni, Gwadur, and Tiz instead of the Turks. Further than this, it is not easy to trace any connection between the Portuguese and Baluchistan or Makrán. The moral of history lies in the fact that it was on these seas that in 1554 the Turkish naval power was first broken by the Portuguese in that fight of which Haji Khalifa so quaintly relates that "the battle was even greater than that between Khair-u-din and Andrea Dorea. Few soldiers are known to have ever been



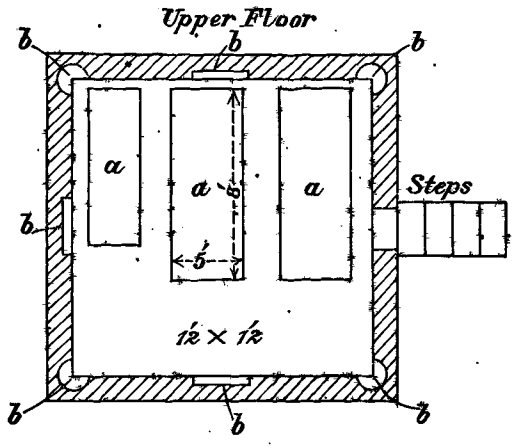
The ruins at Guachig in Dehwar near the Mashkel Hamun

From memory.

Litho, S I. O., Calcutta

NORTH.

Walls of upper storey about 2½ to 3′ thick. Lower storey walls appear much thicker.



Half way up the wall of the upper storey there is a little window facing North, the door being always to the East.

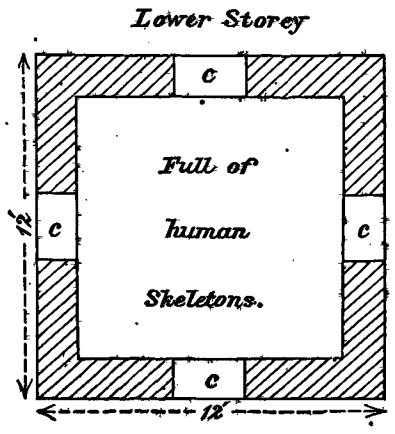
a a a Tombs built up from the floor, and the sides of the sarcophagus ornamented.

Heads of tombs pointing North.

These tombs are built of sun-dried brick, and resemble sarcophage in general appearance.

b b b Alcoves or recesses in the wall; bottom 2 to 3 inches off the floor and height about 8 to 10 feet. From 10 inches to 1 foot in depth.

WEST.



c c c c Low arches, forming what are apparently vaults. The inside of the ground floor or lower storey is full of skeletons. The arches appear to have been built up with brick and mud mortar after the corpses were placed inside.

SOUTH.

engaged in such a fight." Those who know the climate of Muscat, and who can picture to themselves that hard-fought battle raging through the length of an August day, will agree with the historian that it must have been warm work. This battle diverted the whole trade of the East into new channels, and practically created a new epoch for Asiatic commerce. Yet once again was the fate of Asian trade decided by a naval engagement in these waters. This time it was off Jask, on the Makrán coast, that the "*London*," the "*Eagle*," and two other ships finally established British supremacy in 1620, and broke the power of the Portuguese for ever. For three centuries has England held her own, and now perchance it is time again to reckon up the value of this Asiatic trade that seems almost as if it were slipping from her; to count how much of it may be reached from the Makrán coast; what are the means of reaching it; and in whose hands the means now lie.

Extract from a Report by MR. T. E. M. CLAUDIUS, *Extra Assistant Superintendent, No. 15 Party, on his Survey Operations in* MAKRAN, *Season 1891-92.*

I reached Bela on the 18th December 1891 and after making postal arrangements and settling a few other matters connected with transport, etc., I marched for Kolwah *viâ* the Jhao Lak. On reaching Jhao, I despatched Duffadar Gopal Singh in a northerly direction to take up the revision work required in one of the sheets, and then went on to Duffadar Jaganath's portion, and worked with him for a few days, as the soldier-surveyor had done no work on the 1-inch scale previously. After being satisfied that he had a good idea of what he was to do, I marched for Kolwah and reached Chambor on the last day of December. On the 1st January I commenced the reconnaissance for my triangulation from the side Sagár-Hôr. This part of the work occupied me about 20 days. After identifying two stations of the Gwadar triangulation, Sami-Pidark, which formed the side on which I was to effect a junction, and also two points on the north, Taptap-Sobajik, of Major Talbot's triangulation executed during Sir Robert Sandeman's mission in 1883-84, I started my observations about the end of January and completed the same on the 22nd of February. During this time, ten stations, most difficult of approach and access, were observed at; a junction was effected both on the north and west with previous work, and a number of intersected points fixed on the south down to the sea coast. The observations were speedily computed out, and the data supplied to the plane-tablers most needing them.

The extension of the Makrán series was carried principally across the portion of Makrán called Kolwah, which was well described by Mr. Graham in his report in 1890-91. and there is little of importance to add to that report. The highest and most conspicuous summits of the two ranges of hills which flank the Kolwah plain, north and south, were chosen for stations, and the only signals which could be adopted were cairns. Fortunately the inhabitants, unlike the Mingals of the Zidi and Bela districts, did not destroy the signals.

The country plane-tabled by Yusuf Sharif and Sheikh Mohiudin had not been previously traversed by any triangulator, and the following is a description from a few notes supplied to me by the latter.

The most important rivers are the Hingol and Basol. The former has its source a few miles south of Kalat, and running almost due south, empties itself into the Arabian Sea about 50 miles west of Sonmiani. Its total length is nearly 250 miles, and its drainage has an area of nearly 8,000 square miles. Having an easy gradient almost throughout its whole course, with open ground generally along both banks, it is supposed to be well suited for any line of railway to follow. The Basol river empties itself into the sea about 24 miles west of the large and important village of Órmara. It takes its source from the well-known hills of Bhairi Hól and Girdánk. Its total length would be about 60 miles, and along its whole course it has a plentiful supply of sweet water. It drains an area of about 2,100 square miles. An inlet of the sea called Kalmat is considered to be well adapted for a harbour. It lies about 40 miles west of Órmara.

One of the principal highways is the one that follows the course of the Hingol river. It is well utilised by the Brahuis of Kalat, and is an easy route for laden camels; it is in fact the most direct and easiest connection between Kalat and the sea coast.

The road from Kurrachee, leading westwards along the coast, passes through the important villages of Sonmiani and Órmara of the Bela district, and thence on to Pasni and Gwadar; the Bazi *kotal*, the only obstacle that has to be crossed, is 32 miles due west of Sonmiani; good water along the route is very scarce. From Chambor of Kolwah a road strikes southwards leading to Órmara; this follows the Basol river nearly along its whole course, and is practicable for laden animals of all descriptions. A great trade is carried on along this route between the inhabitants of Kolwah and Órmara, the former bartering *ghi* and barley for fish and wheat.

Ormara is a large village standing at the northern base of a great flat hill surrounded on three sides by the sea, the connection on the north with the main coast being a narrow strip of land. The hill is scarped on all sides, the summit having an area of nearly eight square miles. At Órmara there is a telegraph office in connection with the Indo-European line. It is not a regular port, but the Government steamers doing duty with the above touch there. The anchorage is within 400 yards of the village. A very large trade is carried on here in fish, the revenue for the same collected by the Jam of Las Bela

being over Rs. 20,000 per annum. Dried fish are exported in every direction—to Kurrachee, Bombay, and even to China. There are about 30 *banias* in this village, and provisions such as wheat, *ghi*, *jawar*, and sugar are always to be had in large quantities. Pasni is another large and important village on the coast. It lies between Gwadar and Ormara and close to the mouth of the Bhairi river. It is similar to Ormara in many respects, but the fish trade is not nearly as extensive.

The Island of Haft Tallar or Astola is in latitude 25° 7′ 12″ and longitude 63° 52′ 9″ and lies about sixteen miles from the coast. It is about three miles long and nearly half a mile in width, standing 213 feet above the surrounding water, uninhabited and perfectly barren.

ARABIA.

Extract from the Report on the Survey Operations in the DISTRICTS IN THE NEIGHBOURHOOD OF ADEN *by* CAPTAIN R. A. WAHAB, R.E., *Season 1891-92.*

The country triangulated consists of a belt of lowland, much of which is sandy desert, extending along the whole length of the coast, and varying in width from 6 to 30 miles; several isolated hills, evidently of volcanic origin, crop out at intervals along the coast line, the principal ones being Aden itself, Jabal Ihsan or Little Aden, Ras Imran, and Jabal Kharaz, the last-named attaining an altitude of nearly 3,000 feet above the sea. The existence of these hills, it need hardly be said, greatly facilitated the work of triangulation, and subsequently of detail survey. Beyond this desert zone lies the mountainous country, leading up to the Yaman highlands, rising steadily to the northward, where several peaks on the borders of the season's work exceed 10,000 feet. It is drained by several considerable streams, of which the Tiban, the Bana, and the Hasan rise on the Yaman plateau, 100 miles or more from the coast, and are eventually absorbed in the irrigation of the fertile plains of Lahej and Abyán.

The inhabitants are Arabs, divided into various tribes and sub-tribes, independent as far as their internal affairs are concerned, but in receipt of allowances from Government of larger or smaller amount, in consideration for which they engage to abstain from raids on British territory and on *kafilas* trading between Aden and the interior. Those tribes in the neighbourhood of Aden, such as the 'Abdali, and some sections of the Subaihi and Fadthli, are amenable to British influence, but those inhabiting the more remote and inaccessible hills have little or no respect for our power.

Of the various tribes inhabiting the district around Aden, the most important, from its proximity to the British border, is the 'Abdali, estimated to number some 10,000. They occupy the delta of the Tiban river and part of the desert tract east and west of it, extending some 30 miles north from the coast to the borders of the Haushabi country. Their principal town is Lahej, the residence of the Sultan, with a population of 4,000, situated in the Tiban delta, 26 miles from Aden. It differs little in appearance from an Indian town of its size. The principal building is the Sultan's palace, an imposing structure of sundried brick, whitewashed, covering with its out-buildings a considerable area. There is also a rest-house for Europeans, and a small house belonging to the native Assistant Resident. The town stands in the richest part of the oasis, surrounded on all sides by fields of *jawar*, yielding three and sometimes four crops in the year. The date-palm is also grown, though not very extensively, and Indian corn and European vegetables of various sorts are grown for the Aden market. The soil is extremely rich and is irrigated by skilfully-made canals from the Tiban river. Waht and Fiyush are among the principal villages, and numerous hamlets are scattered about throughout the oasis.

The Sultan receives a stipend from Government of 20,000 dollars, and in addition derives a large revenue from his private lands and from transit dues on all goods passing through his territory to and from Aden, estimated at 50,000 dollars more. He is entitled to a salute of 9 guns on visiting Aden. The dollar, it should be mentioned, is here, as throughout Arabia, from the Syrian desert to the Persian Gulf, the standard of value, and curiously enough the 'Maria Theresa' (Austrian) dollar is still looked on as the only genuine one.

East of the 'Abdali, and extending about 100 miles along the coast east of Aden, is the territory of the Fadthli tribe, estimated at 20,000. The Sultan, who resides at Shukra, a small coast town 70 miles from Aden, has a stipend of $2,160, and, like the 'Abdali chief, entitled to a salute of 9 guns. The present chief has, however, little or no influence with the majority of the tribe. The country consists, in its western and southern part, of the plain lying between the hills and the coast, part of which, the Abyán district, is a fertile tract watered by the Suhebiya Bana and Hasan rivers, the remainder being a sandy desert. East and north-east is a mountainous tract occupied by the Markashi and other warlike and practically independent sub-tribes. The Fadthli villages (in the low country at least) show none of the signs of prosperity apparent in the 'Abdali country; much of the cultivable soil lies waste for want of water, which the Yafi'i, who command the Bana and Hasan rivers, divert on to their own fields. Shukra, the capital, is a small place of some 500 inhabitants, depending chiefly on petty coasting trade; Asala, described by Hunter as a town of 600 houses, does not now contain over 30. Tairan, formerly a large village, is quite deserted, and the Abyán villages, Jawala, Al Kaur, Al 'Amudiya, etc., are mere hamlets of a few huts. Little is known of the hill country or of the tribes occupying

it, who form five-sixths of the whole. The Markashi and other hill tribes are at constant feud with the Sultan, and as stated above are practically independent.

Immediately west of Aden are the 'Akrabi, a small tribe not exceeding 1,000, formerly a section of the 'Abdali, but independent for several generations, and recognised by Government as a separate tribe. Their principal village is Bir Ahmad, 14 miles west of Aden, on the right bank of the Wadi al Kabir, here a dry water-course; and except in its immediate neighbourhood, they have no cultivable land. The rest of their territory, which extends along the coast as far west as Ras 'Imran, and for some 10 miles inland, is desert, but not without value for the wood and camel-grazing it furnishes.

The Haushabi are an important tribe, numbering about 7,000, occupying the hill country to the north of the 'Abdali, and extending northwards and westwards to the Turkish border. On the east they are conterminous with the 'Alawi and the Dthambari. This country is for the most part mountainous and barren; the hill ranges in the north rising to over 7,000 feet above sea-level, but there are fertile strips of land in the valleys of the Tiban and Suhebiya which produce excellent crops. The Sultan resides at Musemir, on the left bank of the Tiban, 59 miles north-west of Aden, not far from the foot of the lofty Jabal Warwa, whose conical peak is a conspicuous land-mark for many miles. His residence is a solid-looking house, built of stone, set in mud, at a little distance from the village, which is merely a collection of grass huts. The only other places of any importance are Raha, comprising several scattered villages in the Suhebiya valley, and Harur, some 20 miles further east on the left bank of the same river. Dar-ad-daula, in the Raha district, was formerly the residence of the Sultans, but owing to the difficulty of controlling his subjects in the distant hilly country to the west the last chief moved to Musemir. Harur is a village of 50 houses with a large extent of cultivable land to the east and south-east irrigated by the Suhebiya river; its chief, though a near relation of the Sultan, considers himself more an ally than a subject and is practically independent.

The Haushabi Sultan is an energetic and capable ruler, and has his tribesmen well in hand. He gave every assistance in his power to the survey party, inflicting summary punishment in one or two cases that were reported to him of obstruction on the part of his officials and subjects. He receives a stipend from Government, and has in addition a revenue of about $5,000 derived from land tax and transit dues.

The 'Alawi are a small tribe located in the Suhebiya valley, between the Haushabi on the west and the Kotaibi and Dthambari on the east. Their total numbers do not exceed 1,500. A considerable proportion of their country is cultivable, and their villages, Jimil, As Sanda, Dthanib, Al Kash'a and several smaller hamlets are picturesquely situated on the low hills at the western foot of the Radfan range. Al Kash'a, a village of 500 inhabitants, is the principal place and the residence of the Shekh, who receives a stipend from Government of $60 per annum. He has, besides, a revenue of some $2,500 made up from land tax and transit dues.

The Kotaibi, Bakri, Dairi and Dthambari tribes occupy the Radfan range, a mass of hills lying between the Suhebiya and Bana rivers, attaining a height of 6,000 feet above the sea.

The Kotaibi are the most important, as they command the high road from Aden to Dthala between Jimil and Al Kafla Owing to their hostile attitude to the survey party, the military escort was strengthened considerably, and Captain Domvile, whose troop was detailed for the protection of the survey camps, remained with Mr. Graham and accompanied him daily on his work until the survey of the Kotaibi hills was completed.

The Dthambari, who occupy the south-western part of the Radfan range, at first behaved in a friendly manner and invited Colonel Stace, the First Assistant Resident, and myself to visit Nakhlain at the southern base of the range; on arrival there, however, they refused to allow the party to proceed further except on terms which the Resident could not have acceded to, and negotiations were therefore broken off.

East of the Radfan range, in the valley of the Bana and the hills east and north of it, are the Yafi'i, a tribe which as yet has come but little under British influence. They are divided into the Yafi' us Sufla and Yafi' ul 'Ulya, or upper and lower Yafi'i. The latter, whose territory adjoins that of the Fadthli, number probably 20,000, and their chief, though not bound to us by treaty, is on friendly terms with the Aden Residency and occasionally visits Aden. The upper Yafi'i tribe is estimated to exceed in number 15,000 men. Their country, which consists of high plateaux and fertile valleys, produces large quantities of coffee, cotton, wheat, barley and wax.

The lower Yafi'i country is bounded on the south by the Fadthli, on the east by the Hadramaut, and on the west by the tribes of the Radfan hills and the territory of the Amir of Dthála. Except the small portion of it which lies in the Abyán between Masána and Khanfar little is known of it, except that it is mountainous, with numerous fertile valleys producing grapes, *jawar*, coffee and madder. In winter the cold is sufficient to freeze the streams. (Hunter's "Account of the Arab Tribes.")

The principal town and residence of the Sultan is Al Kahira, situated among the higher hills, some four days journey from Khanfar, the border village on the south-west, 40 miles from Aden. The present Sultan has generally shown himself well disposed to our Government, and it was expected that no objection would be made to the survey of the lower part, at any rate, of his country. It was not, however, till quite the end of the season that any reply was received to the Resident's letters acquainting him with the objects of the survey and requesting his assistance, and though he then protested his willingness to

assist, his officials refused Mr. Graham permission to enter Yafi'i territory, and put him off from day to-day with excuses, under pretence of referring to the Sultan himself for orders. Mr. Graham, however, succeeded in surveying all the country from Masána downwards, and it is doubtful whether the Sultan would have agreed to allow the surveyors to enter his country above that place.

The territory of the Amir of Dthála lies in the extreme north of the country surveyed, immediately bordering on Turkish Arabia, by which it is bounded on the north and west; on the east its boundary is somewhat indefinite, where the Halmain and other tribes have practically thrown off their allegiance to the Amir, though still nominally his subjects. The Amiri country is a high plateau averaging 5,000 feet above the sea, forming the first step, so to speak, between the low country and the Yaman highlands. The climate is temperate and healthy, the thermometer at Dthála in the winter months ranging between 45° and 70° Fahr., while the summer heat is tempered by a regular but not excessive rainfall. There is a considerable area under cultivation, the principal crops being wheat, Indian corn, *jawar* and *bajra;* irrigation is not resorted to, the rainfall being sufficient in most seasons.

The principal towns are Dthála, the residence of the Amir, Dthubaiyyat, a Saiyad settlement about 8 miles to the south, and Harir about the same distance to the east, situated on a flat-topped hill 7,000 feet above the sea. Kafla Zubed, Al Husen, Al Wa'ra and Dthi Harrán are among the principal villages on the plateau; and Al Hamra, Ar Rado Al Markula and Al Khuraiba in the Hardaba valley to the south.

Dthàla is situated in the south-west corner of the plain at the foot of a low hill on which the Amir's fort stands. The town is an irregularly-built collection of stone huts with numerous substantial two and three-storeyed towers. There are several shops, chiefly kept by Jews, who, in spite of oppression and ill usage from their Muslim rulers, manage to keep most of the trade of the country in their own hands, and on market days the place is thronged with buyers and sellers from the whole country side, when supplies of all sorts, grain, vegetables, cloth, live stock, and even kerosine oil, candles and matches, are obtainable. The population is given in Hunter's "Account of the Arab Tribes" at 2,000.

Dthubaiyyat is a large Saiyad village on the remarkable flat-topped hill which forms the southern buttress of the Dthála plateau. A mile to the east, on the highest point of the hill, is the *ziarat* of Wali Hasan, the white dome of which is visible on a clear day from Aden, 70 miles distant. Its elevation is 5,800 feet above the sea, and some 3,000 feet above the country at its southern base. The change in climate from the trying heat of the plains to the cool mountain air of the Amiri hills is very marked, the difference in the temperatures at Jimil, 10 miles from Dthubaiyyat, and on the plateau above being as much as 20° from the observations taken during the winter months. The difference is said to be still more in summer.

Last among the tribes whose lands came under survey during the season are the Subaihi, a large tribe numbering 12,000, occupying the maritime plain from Ras 'Imran, 16 miles west of Aden, to the Straits of Bab-al-Mandab, and the lower slopes of the hill ranges bordering the plain on the north.

The tribe is sub-divided into a number of sections, some of which are subsidized by Government, and some are under Turkish control; but the greater number are independent and do not even own the authority of their nominal chiefs. They were at one time placed under the control of the 'Abdali Sultan, but this arrangement was found unsatisfactory, and the sections subsidized now receive their allowances direct from the Aden Residency.

The greater part of their country is desert, though it affords pasture to numerous flocks of sheep and goats belonging to the nomad families who are always to be met with near the various wells. These are generally found along the dry torrent beds which cross the plain at intervals of 10 to 20 miles, and in several places on the sea shore itself within a few feet of high water-mark. The nomad sections of the tribe have no permanent settlements, but move about with their flocks wherever pasture and water are to be found. There is no cultivation to speak of.

The portion of the Subaihi country lying on the hills bordering the desert, though comparatively small in area, contains probably five-sixths of the entire numbers of the tribe. A fair proportion of it, especially that part watered by the Wadi Ma'adin and its tributaries, is fertile and well populated. There are also several villages and forts on the Am Dukhail river near its exit from the hills. Owing to the hostile attitude of the inhabitants, who twice attacked the surveyors while working near the foot of the hills, the survey of that part of the country was left incomplete.

The only trade routes of any importance are those leading north and north-west from Aden towards Sana', the capital of Yaman, and Ta'iz, the chief town of the Turkish district of that name, respectively. The routes running east and west along the coast are of little importance, the small local traffic between Aden and the coast towns being more easily carried by sea.

The Sana' road leaves British territory at Shekh Othman, a large settlement of Somalis and other miscellaneous nationalities employed as labourers in Aden, and for 10 miles further crosses a desert tract, over hard, sandy ground with occasional patches of thorn jungle till, at about 20 miles from Aden, the beginning of the Lahej oasis is reached, and at 26 miles the town itself, standing in the midst of a highly cultivated plain covered with crops at all seasons. Above Lahej, the road follows the bank of the Tiban river as far as the small fort of Al'Anad, the border post of the Haushabi Sultan. Here the

character of the country changes; the open plain stretching away to the coast is left behind, and the path now runs up a dry torrent bed and through low rocky hills for the next 25 miles to Jimil, where it strikes the Suhebiya valley in 'Awlaki territory. From Jimil, the road follows the Hardaba stream (a branch of the Suhebiya) passing close under the lofty Dthubaiyyat mountain, and winding along the river bed, sometimes through the running stream between banks covered with tamarisk, thickly overgrown with luxuriant creepers, sometimes over the fields on either bank, past villages and towers perched on the rocky spurs above, till the pass or *nakil* of Al Khuraiba is reached, leading up to the Dthála plateau. The path, here a roughly-paved, stepped causeway, one of the few monuments of the former civilisation of Yaman, leads up the rocky gorge, rising 400 feet in the first quarter of a mile. Thence still ascending but at an easy gradient, it emerges a mile further on to the Dthála plain. Looking northward from the head of the pass, the broad cultivated valley dotted with trees and villages slopes gently to the foot of the Mares range, 10 miles distant, which rises in a steep scarp 2,000 feet above the plain; to the right is a lofty flat-topped hill, on the summit of which the tower of Harir, 7,100 feet above the sea, stands out conspicuously, and to the left front is Jabal Jihaf, with towers crowning its highest peaks, and villages and terraced fields lying on its lower slopes. The road to Sana' leads on northward through Ka'taba, the Turkish frontier post, near which the steep ascent of the Mares range commences; that to Dthála turns westward, and passing the village of Jaleli on the right, the Amiri capital is reached some 5 miles from the head of the pass. The total distance from Aden to Dthála is 87 miles by this route, and it is usually covered by *kafilas* in three days.

The Ta'iz route diverges from the above road at Al'Anad, from which point it follows the left bank of the Tiban up to Musemir, the Haushabi capital, 59 miles north-west of Aden; thence through hilly country to the foot of the Am Amma range, which is crossed by a pass probably over 6,000 feet in height, and a few miles further reaching Mávia, a considerable town in Turkish territory. From Mávia to Ta'iz the direction of the road is more west or southwest. Ta'iz is the residence of the Turkish Governor of south-western Yaman, and is a place of some importance as an *entrepôt* for trade between the coast towns of Mokha and Hadeda and the interior; its distance from Aden is 106 miles.

The principal rivers are the Tiban, the Bana, and the Hasan. The Tiban rises in the highlands between Dthála and Sana' about 120 miles from the sea. Its course was surveyed from a point a few miles north of Musemir, where it emerges from a rugged gorge among high mountains; 5 miles below Musemir it receives two tributaries—the Warezán rising in the Am Amma range, and the Akkán from the Kubáti hills, both perennial streams; for the next twenty miles it runs in a south-easterly direction through a valley, one to four miles in width, bounded by barren stony ranges of no great altitude. During this part of its course the banks are gravel or conglomerate, 50 to 100 feet in height and 300 or 400 yards apart; the strips of alluvial soil in the river bed between the actual channel and the high banks are cultivated wherever practicable and irrigated by channels taken off from the stream at suitable points. At Al'Anad the high banks disappear, and the river enters the alluvial plain; 2 miles below Zaida it bifurcates, and the delta so formed constitutes the Lahej oasis.

The western or larger of the two branches, the Wadi al Kabir, finds its way to the sea a few miles west of Shekh Othman; the eastern branch, the Wadi-as-Saghir, loses itself in the low marshy ground between 'Imad and the coast. A large proportion of the water from the Tiban is taken up by canals for irrigating the fertile country around Shaka' and Zaida, and in the delta; the area commanded by the canals is about 20 square miles. In heavy floods, a large quantity of water reaches the sea by the Wadi al Kabir, but as a rule all that is not used up in irrigation is absorbed in the sandy bed some miles before reaching the coast.

The Bana river also rises in the Yaman highlands, and like the Tiban drains a large area of mountainous country. A branch of it is crossed on the road to Sana', two marches north of Ka'taba, where it is already a considerable stream. Its course for some distance is easterly, till it enters the Yafi'i country where it turns south, and skirting the eastern foot of the Radfan range, it finally enters the plains at AlMasána near the border of the Yafi'i and Fadthli lands.

The Hasan river enters the plain near Masána within a mile of the Bana, but follows a separate course to the sea; both rivers have a constant stream of water down to their exit from the hills, where all available water is taken off for irrigation. Unfortunately, owing to constant feuds between the Yafi'i and Fadthli, much of the fertile tract of land in Abiyán, which depends on these streams for irrigation, now lies waste for want of water. Endeavours have been made by the political authorities at Aden to effect some agreement between the two tribes regarding the distribution of the water, but with little success.

UPPER BURMA.

Description of the country surveyed by No. 3 Party in Season 1891-92,

SAGAING DISTRICT.

The Sagaing district lies between Lat. 21° 40′ and 22° 10′ and Long. 95° 10′ and 96° 0′. It is divided by the Irrawaddy river into two sections. The lower section, or Ava sub-divi-

sion, is bordered on the east by the Kyaukse district and on the south and west by the Myingyan district : the northern section extends westward from the Irrawaddy to the Chindwin river, and is divided into two sub-divisions, Sagaing and Myin Mu, separated from each other by the Mu river. On the north, the Sagaing sub-division is bounded by the Shwebo district, and the Myin Mu sub-division by the Lower Chindwin district. Each sub-division is again divided into two townships, and the whole comprises 175 circles or *taiks* These have now again been sub-divided into 1,150 *kwins* or *ywas*, though each *kwin* does not necessarily contain a village site ; in fact, it is an arbitrary division, lately adopted for administrative purposes, and was unknown here before. The actual number of *ywas*, or true villages, is only 546, though several consist of two or three hamlets of the same or different names.

The Irrawaddy river, after running south between the Mandalay and Sagaing districts for 25 miles, turns westward between the towns of Ava and Sagaing, and taking a semi-circular sweep, again resumes a southerly course before its junction with the Chindwin. For the greater part of its course, it runs between high banks, about a mile apart, which are only occasionally overflooded when the river rises to an unusual height. But at intervals, where water-courses run into the river from the interior, the water rises into them, and creeks are formed, which, in their turn, fill large depressions which occur at intervals, turning them into small lakes or marshes, known as *ins*, in which the water is dammed up and subsequently used for irrigation. These marshes and the irrigated lands round them were, as a rule, held as service lands and fisheries free of rent, by families who supplied rowers for the king's war boats. As this service is no longer needed, these now pay rent to Government and are a source of considerable income. As it approaches the Chindwin river, the Irrawaddy throws off several lesser channels which cross the prolonged fork between the rivers, and when flooded irrigate a large tract of country in which rice crops are raised. The Chindwin, which bounds the district on the west, is about three quarters of a mile wide from bank to bank. During the rains, the entire bed is covered, and farther north, where it twists and turns considerably, navigation becomes dangerous. But in the dry season the small steamers drawing only 18 inches often strike on the sand banks owing to the small supply of water.

The Mu river, which winds across the upper section of the district and falls into the Irrawaddy about 20 miles below Sagaing, is only about 250 yards across, and during the dry weather has a very slender stream of water in it. But it becomes unfordable at times when heavy rain falls on the hills of Wuntho at its source. These are the only rivers in the district, and there are no streams of importance, though numerous dry water-courses fall from the various groups of hills.

A low range of rocky hills skirts the Irrawaddy opposite the Mandalay district, rising in height at the northern end at Mingun to 1,340 feet, and descending to hillocks near Sagaing. The descent on the east to the Irrawaddy is steep and rugged, the small strips lying between the hills and river being covered with *phayas* and *phoongyi kyoungs* (pagodas and monasteries), one being the huge unfinished structure at Mingun, famous for its large, now useless, bell. The descent on the western side is more easy, and the country gradually falls away to the plains over which the railway line is carried. One long undulation rolls westward north of Sagaing across the district, sometimes rising into groups of hills, at others falling to the level of the surrounding country. From these hills and uplands numerous water-courses and ravines break into the plains with gently sloping spurs between. Near the bases of these slopes, the villagers raise long low dams or *kazins* of mud and thereby collect and store the rainfall, such as it is, some 20 inches in the year, in *kans* or tanks, whence it is afterwards gradually drawn off to irrigate patches of adjacent country, for rice cultivation. With an increase of population, this system could be almost indefinitely extended over the district.

In the Ava sub-division a group of hills lies to the south of the district, rising at Mozataung, a station of the Great Trigonometrical Survey, to 1,474 feet in height. There are also two or three more minor groups and undulating downs across the country, as in the northern section, where also the rainfall is utilised as above described.

Except in the lands irrigated by *ins* and *kans*, where rice is cultivated, the chief crops raised are *jawar*, sessamum, gram, peas, and cotton. The last is brought in large quantities to the store of a Chinaman in the village of Ywathitgyi, 13 miles below Sagaing. Here it is cleaned by women and girls, of whom from two to three hundred are employed constantly. It is then pressed into bales and sent on board the Irrawaddy Flotilla Company's cargo boats, chiefly to Bhamo, for the China market, or to Rangoon.

A large portion of the district is very dry and covered with thorny scrub, acacias, plums, and other hard woods, with cacti, prickly pear, and numerous creepers, which bind the whole together and render line-clearing very difficult.

Only about half of the entire area surveyed is or has been cultivated, but there is no reason why a much larger area should not be brought under the plough with an increase of population. Near the rivers may be seen several large mango groves, but, as a rule, the district is painfully bare of timber and fruit trees.

The villages are, as a rule, small collections of thatched bamboo huts surrounded by thorny fences and provided with gates for the prevention of cattle lifting, for which the district was notorious not long ago. Sagaing and Ava might rank as towns, though the latter is rather a mass of ruins interspersed with huts.

Ywathitgyi, where the camp was pitched during the field season, is a large village, occupied partly by Buddhists, partly by Mahomedan Burmans. One peculiarity of the

latter noticed by our Indian Moslems was, that the women as well as men learned to read and recite from the Koran, and attended worship in the *musjids*. There are numerous *phayas*, *kyoungs* and *zayats* scattered all over the district, many nicely built of teak; in those last our men were always accorded ready accommodation, which I am happy to say was seldom abused.

Near Chaungoo are two villages of what are now practically Burman Roman Catholics, the descendants of Portuguese captives brought from Syriam by Aloungphya (or Alompra) when he captured Pegu. They had to a great extent adhered to the Catholic form of worship when found by the priest, who has since taken charge of the community.

There was practically no rainfall, and great scarcity of water in parts of the district during the dry months, but the rain in May staved off what might have been a very serious water famine. There are very few district roads, but numerous cattle tracks cross the country in all directions; so there are no transport difficulties during the dry months, and good riding ground everywhere.

Game abounds in parts, especially along the rivers, including geese, ducks, snipe, jungle fowl, partridge and quail, a large and small species of deer, boars, and leopards. Otters of a very large size and with a splendid skin are found along the river banks.

Chindwin Coal Tracts.

The Chindwin coal tracts lie between Lat. 23° and 24° and Long. 94° 15′ and 94° 20 between the Myitha valley and the Chindwin river. The seams, judging from the outcrop, run almost exactly north and south, and vary in thickness from a few inches to in one case 12 feet. Of the entire tract, only the portion lying between the first and second ranges of hills west of the Chindwin was surveyed.

The entire tract is a mass of rugged hills, covered with dense jungle, and, except near the Kalwa stream, entirely uninhabited. The section surveyed is divided into three small valleys, known respectively as the Paluswa, the Nautahin and the Kale, each drained by a main stream, which, after collecting all the drainage from the high range to the west, known as the Noebetaong or Yoma, breaks through rugged defiles in the outer range and flows into the Chindwin. The Noebetaong rises to about 3,000 feet above sea-level; its farther slopes are an intricate mass of forest covered spurs which were not surveyed. Its eastern slopes fall into the valleys named above, sometimes in long spurs, at others in precipitous rocky crags. The latter are quite inaccessible; the former may be ascended by keeping along the crests, but even so are difficult, as at intervals they are broken by sudden precipices of smooth-faced rock, 40 to 50 feet in height, which can only be passed by proceeding down one side of them to the nearest water-course and then climbing back under them again to the crest, and following that till the next precipice has to be flanked in the same way. Sometimes these tiresome *détours* are saved where a slight coating of clay has fallen and overlies the rock, when with care a direct descent can be made. Between the spurs, narrow water-courses fall over large boulders, and are fringed by dense forest and undergrowth, making them quite inaccessible as a rule. There are a few fir trees on the Noebetaoung stream, and the Bombay-Burma Trading Company's agents at times cut and bring down timber from the hill-sides, the logs being washed down the water-courses to the main streams, from which they are dragged away by elephants with immense labour. But the greater portion of the trees are small and not valuable, and a considerable area is covered with bamboos. During the rains, the streams are roaring torrents and are quite impracticable for man or beast. During the dry months, the stream beds may be ascended with much labour over the boulders, but the few people who enter the valleys, usually ascend by pathways which cross the crest of the outer range from Matu and other villages near the Chindwin, which river is here 900 feet above sea-level. These after crossing the open country near the river, ascend by zigzag routes, crossing lesser water-courses and several spurs, then over passes averaging about 2,000 feet above sea-level: they next descend through equally rough tracts to the central streams, which are about 1,500 feet above the sea, and continue up various spurs to the passes on the Noebetaoung. In one of these passes I remarked rude cuttings on the rocks, indicating the routes taken by a party of Chin marauders some years ago which burst on some small Burmese villages in the low country and killed or carried away every inhabitant and all their cattle.

The coal seams appear in the beds of the main and lesser water-courses at intervals, for some three miles in breadth, the rocks between the various seams being grey shale, sandstone, and slate. The total breadth of all the seven seams that appear above the surface in the Nautahin valley aggregate only 11 feet 10 inches of good coal, and the two seams in the Sadwin, a feeder of the Nautahin, are respectively 4 and 12 feet in width according to Dr. Noetling's report.

These have been, for a length of 3 miles, included in the blocks demarcated for the Buckland Syndicate; similar blocks may hereafter be available in the Paluswa and Kale valleys when needed. But until a good road is cut from Kalewa, running north, through Kale, Nautahin and Paluswa to the Chindwin below Kindat, the coal is quite cut off from the river: and, even then, the rush of water in the rains would soon flood all works in the beds of the valleys. So, as Dr. Noetling remarks, it will probably be necessary to cut a tunnel 5,000 feet long from the base of the hills opposite Matu to get at the coal in the Nautahin. After getting the coal to the rivers, the question of its transport on the

small steamers that ply on the Chindwin must be considered. During the rains, the navigation is perilous owing to the violence of the current when swirling round rocky ends of spurs that abut on the river. During the dry weather, the vessels stick often in 18 inches of water. Local labour was practically not to be had, and even the usually patient and docile Hazaribagh *khalásis* at one time struck work.

All food had to be carried by the men themselves from the villages on the banks. Matu and Massein, where fortunately rice of good quality was obtainable at prices not much in excess of those prevailing at the time in Mandalay.

Elephant tracks were seen in several places, but these were probably those of the Bombay-Burma Trading Company's animals. There were also tracks of wild buffaloes and leopards. *Hooluks* (Gibbon) howled in the wilder recesses, and the ordinary jungle fowl and deer abound. Water is abundant, clear and sweet in every stream. The tract is said to be very feverish after the rains, but in the winter months the climate was excellent, and only one serious case of fever occurred among the native establishment, though both the European officers suffered.

ELECTRO-TELEGRAPHIC LONGITUDE OPERATIONS.

Extract from the Narrative Report of CAPTAIN S. G. BURRARD, R.E., *in charge No. 22 Party (Astronomical), Season 1891-92.*

The arcs of longitude assigned for measurement during the season were as follows :—

(1) Calcutta-Waltair.
(2) Waltair-Jubbulpore.
(3) Waltair-Madras.
(4) Waltair-Bolarum.
(5) Bolarum-Bombay.
(6) Fyzabad-Dehra.

In 1877 two arcs had been measured from Vizagapatam, *viz.*, Vizagapatam-Madras and Vizagapatam-Bellary, Colonel Heaviside observing at the Vizagapatam terminal of each.

On my arrival at Vizagapatam, I found that a Roman Catholic mission school had been built over Colonel Heaviside's station, and that his site was not only no longer available for an observatory, but that it could not be discovered without damage to the school house. I accordingly selected a new longitude station at Waltair, which was within three miles of Colonel Heaviside's, and which fulfilled all necessary conditions admirably.

If the old station at Vizagapatam had been still available, it would this season have been connected with Calcutta, Jubbulpore, and Bolarum only; but as Waltair had to be substituted, it was considered advisable to not only observe the Calcutta-Waltair, Waltair-Jubbulpore, and Waltair-Bolarum arcs, but to also measure the arc Waltair-Madras, and to reject the old arc, Vizagapatam-Madras. The two Vizagapatam arcs of Volume IX, Great Trigonometrical Survey, have therefore been excluded from the final reduction of the Indian longitudes.

We commenced work on the Calcutta-Waltair arc on 6th December and completed it on 12th December 1891. The telegraph line for the greater part of its length followed the coast line of the Bay of Bengal, and, owing to the humidity of the air and the bad condition of the line, the insulation was most defective, and signals very difficult to receive. On the next arc, Waltair-Jubbulpore, the telegraph wire ran *viâ* Calcutta, so that our currents had not only to pass over the same 550 miles of coast line as they had in the previous arc, but also over an additional length of 750 miles from Calcutta to Jubbulpore. As was to be expected, we failed entirely to pass any signals through, and we were compelled to introduce a translating station at Cuttack.

The retardation of the current on this arc was found to be 0·191 of a second, a quantity almost double in amount the largest value hitherto obtained and more than four times in amount the average value of the retardation on an ordinary arc.

FINAL RESULTS OF THE SEASON'S WORK.

The values of the arcs measured during the season 1891-92 are here given in tabular form.

Arcs.	Telegraphic value of Longitude.			Geodetic value of Longitude.			Telegraphic *minus* Geodetic.
	h.	*m.*	*s.*	*h.*	*m.*	*s.*	*s.*
1. Calcutta-Waltair . . .	0	20	9·194	0	20	9·684	−0·490
2. Waltair-Jubbulpore . . .	0	13	28·501	0	13	28·060	+0·441
3. Waltair-Madras . . .	0	12	16·868	0	12	16·612	+0·256
4. Waltair-Bolarum . . .	0	19	11·525	0	19	11·482	+0·043
5. Bolarum-Bombay . . .	0	22	48·785	0	22	49·480	−0·695
6. Fyzabad-Dehra . . .	0	16	20·700	0	16	19·067	+1·637

The correctness of the telegraphic values of our arcs may be tested as follows:—

		m.	*s.*
(i) Calcutta-Waltair	=	20	9·194
Waltair-Jubbulpore	=	13	28·501
Their sum gives the value of the arc, Calcutta-Jubbulpore	=	33	37·695
Calcutta-Jubbulpore, as observed in 1882-83	=	33	37·702
Closing errror	=	0	0·007
(ii) Waltair-Jubbulpore	=	13	28·501
Waltair-Bolarum	=	19	11·525
Their difference gives the value of arc, Jubbulpore-Bolarum	=	5	43·024
Jubbulpore-Bolarum, as observed in 1880-81	=	5	42·935
Closing error	=	0	0·089
(iii) Waltair-Bolarum	=	19	11·525
Waltair-Madras	=	12	16·868
Their difference gives the value of the arc, Madras-Bolarum	=	6	54·657
Madras-Bolarum, as observed in 1875-76	=	6	54·615
Closing error	=	0	0·042
(iv) Waltair-Madras as observed in 1891-92	=	12	16·868
Deduct geodetic difference of longitude between the longitude stations at Vizagapatam and Waltair, as obtained by triangulation	=	0	6·913
The remainder should give value of Vizagapatam-Madras arc (provided that local attraction at Waltair and Vizagapatam is the same)	=	12	9·955
Vizagapatam-Madras arc as observed by Colonel Heaviside in 1875-76	=	12	9·935
Discrepancy		0	0·020
(v) Fyzabad-Agra, as measured in 1882-83	=	16	27·995
Dehra-Agra, as measured in 1885-86	=	0	7·233
Their difference should give the value of the arc, Fyzabad-Dehra	=	16	20·762
Fyzabad-Dehra, as measured in 1891-92	=	16	20·704
Closing error	=	0	0·058
(vi) Mean circuit error for the season 1891-92	=	0	0·049

RETARDATION.

On any arc measured between stations E and W, let the retardation of the current from E to W be t' and from W to E be t''. Let the value of the arc of longitude, as found by observations with E clock, be ΔL_E, and when determined by observations with W clock ΔL_W, and let ΔL be the true difference of longitude required. Then $\Delta L = \Delta L^E + t' = \Delta L_W - t''$.

ΔL_E and ΔL_W are known quantities given by observation, and their difference is equal to $(t' + t'')$. The value of $\left(\frac{t' + t''}{2}\right)$ is here given for each of the arcs measured during 1891-92; it will be seen to be unusually large throughout the season, and attains its maximum value (as was pointed out before) on the "translation" arc, Waltair-Jubbulpore.

Arcs.	ΔL_E		ΔL_W		$t'+t''$.	$\frac{t'+t''}{2}=p_o$
	m.	*s.*	*m.*	*s.*	*s.*	*s.*
1. Calcutta-Waltair	20	9·081	20	9·306	0·225	0·113
2. Waltair-Jubbulpore	13	28·310	13	28·692	0·382	0·191
3. Waltair-Madras	12	16·764	12	16·971	0·207	0·104
4. Waltair-Bolarum	19	11·418	19	11·631	0·213	0·107
5. Bolarum-Bombay	22	48·699	22	48·871	0·172	0·086
6. Fyzabad-Dehra	16	20·621	16	20·786	0·165	0·083

Experiments on the Object Glasses.

First series of experiments.

The first experiments that were carried out were as follows:—The two collimators were set up and most carefully aligned upon one another, great caution being also taken that the cube of the telescope did not partially obscure mutual vision: the value of C_o was then determined. The collimators were then moved laterally through half an inch, and C_o again determined. They were then raised half an inch, and C_o again determined: in all positions their optical axes remained parallel to their original position. In these experiments the object glasses of the two collimators remained accurately aligned and superimposed, but at each determination of C_o a different position of the object glass of the telescope was brought into play, and it was expected that this difference would cause a change in the value of C_o, but no alteration in the value of C_o was observed, and no difference between C_E and C_W detected.

The diameter of the object glass of the telescope is five inches, that of the aperture in the cube $3\frac{1}{4}$ inches, and that of the object glass of a collimator $2\frac{1}{2}$ inches. As it is essential that mutual vision between the collimators should be obtained without any interruption by the telescope, the extreme lateral movement possible is three-quarters of an inch, and in practice not more than half an inch. Although, therefore, the object glass of the telescope has an area of 20 square inches, only a circular portion of it (the size of the collimating aperture) about seven or eight square inches in area, at the centre, is available to experiment on.

Second series of experiments.

The second series of experiments carried out were as follows:—C_o was first determined from horizontal collimators, then from vertical collimators, and then from collimators inclined to the horizon. The object glasses of the collimators were most carefully aligned and superimposed in every case, and the collimating hole was placed truly between them. No alteration in the value of C_o was observed, and no difference between C_E and C_W detected, whether the collimators were horizontal, vertical or inclined.

Third series of experiments.

The third series of experiments was as follows:—The telescope was first placed in position, and in intersecting the cross of the northern collimator with the vertical wire of the southern, view was obtained through the collimating aperture; with these conditions holding, four readings were taken and recorded. The telescope was then removed and four readings obtained with uninterrupted vision. The process was repeated four times in each pivot position of both telescopes. It was found that if the collimating aperture be carefully aligned between the two collimators, no change in the reading of the collimator cross will be caused by the removal of the telescope; in other words, the interposition of the telescope between the collimators has no effect. But if alignment is not careful, and portions of the object glasses of the collimators be rendered ineffective by the interruption of the telescope, the removal of the telescope will cause an alteration of perhaps one or two divisions in the reading of the collimator cross. In regular longitude work no great care in alignment is ever taken, and the position of the collimating hole might easily be shifted laterally through a quarter of an inch at change of pivot.

Fourth series of experiments.

The quantity C_o is too complex a quantity to experiment on. It depends on no less than four different readings, *viz.*, A, B, D and E, and its formula is $C_o = \frac{D+E}{2} \mp (\frac{A-B}{2})m$. Now, say, we determine C_o, and then move the collimators and re-determine it: moving and re-adjusting collimators occupies much time, and we are fortunate if we get three or four values of C_o in one night, if they have been taken under quite different conditions. When we have obtained them, we learn nothing. In moving the collimators we alter three out of the four readings, *viz.*, A, D, and E by large amounts, so that if two successive values of C_o do differ, all we know is that the complex formula $\frac{D+E}{2} \mp (\frac{A-B}{2})m$ has changed in its result, but we cannot

put our finger on the exact term of the formula, and say to which of the numbers A, D, E the change is due. So that even when we do succeed in changing C_o, as I did in 1890, by tilting my collimators, all we know is that C_o has changed as a whole, but we are ignorant as to what elementary term in C_o has changed. In moving collimators, D and E will be changed by 200 or perhaps 400 divisions, and A by possibly 150 divisions, whereas variations in C_o are confined within limits of 10 divisions. What happens as often as not, too, is that variations in A, D and E tend to cancel, and though each may be suspected of change, the resulting value of C_o remains the same.

For these reasons we were led to give up experimenting on so complex a quantity as C_o, for it became quite clear that the only chance of success lay in attacking the three elementary quantities A, D and E themselves. (B is the reading of the cross of the south collimator on its own micrometer when intersected with its own vertical wire, and so is independent of all external influences.)

The new plan we were gradually led to adopt was this: Suppose we have two telescopes, Y and Z, pointing at one another exactly, their object glasses close together, each telescope being provided with a cross wire at its eye end. The telescope Y has a micrometer, and with it we measure the horizontal distance between the two crosses. We then with a semi-circular cardboard disc cover up the western half of the object glass of telescope Z and re-measure the horizontal distance between the two crosses. We then with the same disc cover up the eastern half of the object glass of telescope Z, then the lower half, then the upper half, reading the crosses each time. Now if the reading is different, when the western half of the object glass of Z is obscured, to what it is when the eastern half is obscured, there is a tendency to think (especially when the two telescopes are 30 feet apart as our collimators are) that the object glass of Z is at fault, but this is not necessarily the case. However far the telescopes are apart, provided they are properly aligned, in covering up the western half of the object glass of Z, we in reality cover up the western half of *both* telescopes, for, as far as mutual vision is concerned, only the eastern half of both is in play, and we are only dealing with parallel rays. So that any change in the reading of the cross of Z on Y's micrometer may be due to a defect in either object glass or both.

In our present experiments we have three telescopes, and experimenting with them two at a time we get three pairs with which to operate.

1st pair.—North and south collimators. Reading of north collimator cross on south collimator micrometer called A.

2nd pair.—North collimator and transit instrument. Reading of north collimator on telescope micrometer called D.

3rd pair.—South collimator and transit instrument. Reading of south collimator on telescope micrometer called E.

I append tables of results, being values of A, D and E taken with different parts of the object glasses obscured. In all cases vision was very fair, but in some cases better than in others. On regular work I have frequently had worse vision of the north collimator cross in the south collimator than I had in any one of these cases, where half the object glass was obscured each time.

We aligned the three telescopes as follows: We put a white cardboard disc over the object glass of the telescope, and threw the light from the lamps at the back of the collimators on to this disc: the collimators focussed the light from their lamps and threw a highly illuminated circle (of the same diameter as the object glass of the collimators) on to the white disc. We moved the collimators until this circle of light in each instance was at the centre of the disc, when the telescope was horizontal. When this had been done, there was mutual vision between the collimators. We then took this white disc and cut out from its centre an aperture of the same size as the object glass of the collimators. In reading D or E with the telescope, the results should have been the same, whether this annular disc was inserted in the object glass of the telescope or not, for, even when it was inserted, all that portion of the glass that intercepted parallel rays from the collimator was still exposed towards the collimators.

The second disc necessary was a semi-circle of cardboard of half the size of the object glass of the collimators. With this semi-circular disc we could obscure not only half the object glass of each collimator, but it would also close up half the aperture in the telescopic disc.

In the experiments on the readings of A, only the north and south collimators are introduced: we covered up in turn the western half, the eastern, the lower and the upper of each collimator.

In the readings of D and E the telescope comes in. In these cases we began with both object glasses wholly unobscured: we then placed the annular disc in the telescope and left it there throughout the remaining experiments. The experiments on D and E consisted in obscuring parts of the object glass of the collimator and parts of the aperture in the annular disc alternately. Alignment being good, the insertion of the annular disc should not alter the readings of D and E from what they were with the whole object glass of the telescope, as no parts of either object glass in play are obscured: the insertion of the annular disc (*vide* Table II) altered D from 1767·5 to 1767·4, and E from 1448·0 to 1448·3. Again, alignment being good, the readings of D and E should be unaffected, whether the semi-circular disc be inserted over half the collimator or over the corresponding half of the aperture in the telescopic disc.

TABLE I.—VALUES OF A (TELESCOPE NO. 1.)

A is the reading of the south collimator micrometer when the vertical wire of the south collimator is intersecting the cross of the north collimator. The collimators were pointing exactly opposite each other; the disc was of cardboard and semi-circular, being exactly half the size of the object glass of either collimator.

	Object Glasses of both collimators open.	Eastern half of Object Glasses unobscured.		Western half of Object Glasses unobscured.		Upper half of Object Glasses unobscured.		Lower half of Object Glasses unobscured.		
	No disc inserted at all.	Disc inserted in North collimator.	Disc inserted in in South collimator.	Disc inserted in North collimator.	Disc inserted in South collimator.	Disc inserted in North collimator.	Disc inserted in South collimator.	Disc inserted in North collimator.	Disc inserted in South collimator.	
Each of the readings in these columns is the mean of two, one taken by Captain Burrard and one by Lieutenant Conyingham	58·2	58·7	59·2	53·9	53·6	57·5	58·0	58·5	59·2	At the end of the experiments A was read again with no disc inserted at all to see that no movement had taken place.
	56·8	58·7	60·2	54·2	54·0	57·5	57·2	59·0	57·0	
	57·0	59·0	57·7	54·2	56·0	59·1	57·3	59·8	56·6	
	58·2	60·2	59·3	55·3	53·0	58·5	57·3	61·0	57·5	
	...	...	...	...	54·3	...	...	...	...	
Means	57·6	59·2	59.1	54·4	54·2	58·2	57·5	59·6	57·6	
Final means	A_o=57·6	A_E=59·2		A_W=54·3		A_U=57·9		A_L=58·6		

The five different values of A are—

- A_o =57·6 with full aperture in use.
- A_E =59·2 „ Eastern half of object glass in use.
- A_W =54·3 „ Western „ „ „ „
- A_U =57·9 „ Upper „ „ „ „
- A_L =58·6 „ Lower „ „ „ „

N.B.—A is in divisions of collimator micrometer; D, E, and C, are always in divisions of telescope micrometer. To convert A (or differences between two values of A) into divisions of telescope micrometer they must be multiplied by 1·666.

TABLE II.—VALUES OF D (TELESCOPE NO. 1.)

D is the reading of the telescope micrometer, when the centre vertical wire is intersecting the cross of the north collimator. Two discs had to be used for the telescope, the first was an annulus, and covered up the object glass of the telescope, with the exception of a circular portion of the same size as the object glass of the collimator; the second disc was semi-circular, and half the size of the object glass of the collimator.

	Object Glasses of Telescope and Collimator open.		Eastern half of Object Glasses unobscured.		Western half of Object Glasses unobscured.		Upper half of Object Glasses unobscured.		Lower half of Object Glasses unobscured.		
	No disc inserted at all.	Circular disc with aperture inserted in telescope.	Semicircular disc inserted in collimator.	Aperture in disc of telescope half covered.	Semi-circular disc inserted in collimator.	Aperture in disc of telescope half covered.	Semi-circular disc inserted in collimator.	Aperture in disc of telescope half covered.	Semi-circular disc inserted in collimator.	Aperture in disc of telescope half covered.	
Means of two readings, one by Captain Burrard and one by Lieutenant Conyingham.	1767·3	1767·5	1769·3	1768·5	1764·2	1766·2	1764·9	1765·0	1771·5	1770·0	At the end D was read again with no disc inserted in either object glass to see that no movement had taken place of either collimator or telescope during the experiments.
	66·9	68·5	69·7	69·7	63·6	65·5	65·3	64·4	69·3	70·8	
	68·0	66·4	68·0	69·0	63·2	64·7	66·0	66·1	69·0	70·0	
	67·8	67·0	68·2	69·1	62·9	65·4	66·0	65·0	69·0	70·4	
Means	1767·5	1767·4	1768·8	1769·1	1763·5	1765·5	1765·7	1765·1	1769·7	1770·3	
Final Means	D_o =1767·5		D_E =1769·0		D_W =1764·5		D_U =1765·4		D_L =1770·0		

The five different values of D are—

- D_o =1767·5 with no obscuration.
- D_E =1769·0 „ Eastern half of object glass of collimator in use.
- D_W =1764·5 „ Western „ „ „ „
- D_U =1765·4 „ Upper „ „ „ „
- D_L =1770·0 „ Lower „ „ „ „

TABLE III.—VALUE OF E (TELESCOPE NO. I).

E is the reading of the telescope micrometer, when the centre vertical wire is intersecting the cross of the south collimator. Two discs were used for the telescope, the first fitted the object glass of the telescope, but had an aperture in it of the same size as the object-glass of the collimator; this aperture was placed exactly opposite the collimator. The second disc was semi-circular and the same as in Table I, being half the size of the object glass of the collimator.

	Object glasses of Telescope and Collimator open.		Eastern half of Object glasses unobscured.		Western half of Object glasses unobscured.		Upper half of Object glasses unobscured.		Lower half of Object glasses unobscured.		
	No disc inserted at all.	Circular disc with aperture inserted in telescope.	Semi-circular disc inserted in collimator.	Aperture in disc of telescope half covered.	Semi-circular disc inserted in collimator.	Aperture in disc of telescope half covered.	Semi-circular disc inserted in collimator.	Aperture in disc of telescope half covered.	Semi-circular disc inserted in collimator.	Aperture in disc of telescope half covered.	
Means of two readings, one by Captain Burrard, and one by Lieutenant Conyngham.	1448·2	1448·6	1450·6	1450·4	1447·3	1444·9	1450·7	1450·5	1448·0	1449·0	At the end E was read again with no disc inserted at all to see that no movement had taken place.
	47·5	49·9	50·5	50·0	46·8	45·9	50·7	51·0	45·8	48·2	
	47·7	47·3	50·7	49·7	47·3	46·2	50·4	51·8	47·9	49.0	
	48·5	48·1	50·3	49·9	48·5	48·8	50·6	51·2	47·4	48·5	
Means	1 48·0	1448·3	1450·5	1450·0	1447·5	1445·7	1450·6	1451·1	1447·3	1448 7	
Final Means	E_O = 1448·0		E_E = 1450·3		E_W = 1446·6		E_U = 1450·9		E_L = 1448·0		

The five different values of E are

E_O = 1448·2 with object-glass of collimator full in use.

E_E = 1450·3 „ Eastern half of object-glass of collimator only in use.

E_W = 1446·6 „ Western „ „ „ „

E_U = 1450·9 „ Upper „ „ „ „

E_L = 1448·0 „ Lower „ „ „ „

From the Tables it will be seen that D_W differs from D_E by no less than $4\frac{1}{2}$ divisions, and D_L from D_U by a similar amount. E_W differs from E_E by 3·7 divisions, and E_L from E_U by 2·9 divisions.

It is when we come to A, that we get the most extraordinary difference. The readings of A are in divisions of the collimator micrometer, and have to be multiplied by 1·666 to be brought into terms of the telescope micrometer: as C, D and E are in terms of the latter, this conversion must always be effected. Now A_W = 59·2 and A_E = 54·3; difference = 4·9, collimator divisions = 8·2 divisions of the telescope micrometer. This means to say that the value of A will differ by 8·2 divisions according to whether the western or eastern half of the object-glasses is obscured, the image of the intersected cross remaining clear, distinct, and good throughout.

In the experiments on the reading of A, in which the great discrepancy of 8·2 divisions appears, the telescope does not enter at all, and so this discrepancy must be due to one or both collimators.

Whether the variations in D and E are due to the object-glass of the telescope or those of the collimators cannot be positively stated from the above results, but all the evidence tends to acquit the telescope.

In the first place we are testing the object-glass of the telescope by means of collimators, whose object-glasses are themselves bad, as proved by the changes in A. Variations then in D and E are therefore only to be expected owing to the badness of the collimators, and these variations are no evidence whatever against the object-glass of the telescope.

Secondly, all the old discrepancies between C_E and C_W are at once explained, if we admit A to be erroneously determined.

$$C_E = \frac{D+E}{} + \left(\frac{A-B}{2}\right) m \text{ and}$$

$$C_W = \frac{D+E}{2} - \left(\frac{A-B}{2}\right) m$$

C_E will therefore differ from C_W by the amount that A is in error, as half this amount is additive in one case and subtractive in the other.

Thirdly, in adding $D_W - D_E$ to $E_W - E_E$ or $D_L - D_U$ to $E_L - E_U$, any effect of the object glass of the *telescope* should be cancelled, as its effect should be opposite on the two collimators. Now $D_W - D_E = +4{\cdot}5$ and $E_W - E = +3{\cdot}7$: their sum $= +8{\cdot}2$, and this is the exact value of $A_W - A_E$. Again $D_L - D_U = -4{\cdot}6$ and $E_L - E_U = +2{\cdot}9$: their sum $= -1{\cdot}7$, whilst the value of $A_L - A_U = -0{\cdot}7 \times 1{\cdot}666 = -1{\cdot}2$.

If the object-glass of the telescope be faultless the values of D and E will not in practice be erroneously determined, however bad the object-glass of the collimator is, for though in regular work the collimators may point towards different portions of the object-glass of the telescope, the alignment can never be so bad as to throw a portion of the object-glass of the collimator outside the object-glass of the telescope altogether.

If a reading is not altered by bringing a different portion of the object-glass of the telescope into play, then as long as the projection of the object-glass of the collimator is wholly within the object-glass of the telescope, no change in D and E will take place whatever portion of the telescopic object-glass is opposed to the collimator. On the other hand, if any portion of the object-glass of the collimator is thrown out of use from bad alignment, variations will ensue. Though these experiments on D and E are useful in proving the badness of the collimators, yet in practice no portion of the object-glass of the collimators can well remain obscured during the reading of D and E, and so unless the object-glass of the telescope is bad too, the readings of D and E are likely to be correct in all positions; in other words, variations in C_o cannot be attributed to D and E.

In the formula for C_o the quantity that seems most likely to be wrong is A. This quantity is shewn to vary according to the portion of the object-glasses that is obscured. Now in practice it is most unlikely that the object-glasses of the two collimators should be exactly opposed. No steps are ever taken to attain this object: the observer is satisfied if he gets good mutual vision, and good mutual vision with an excellent image can be obtained with only one-third of the object-glasses in play. The collimators have such small object-glasses and are so far apart in practice, that what generally happens is that their object-glasses, instead of being exactly opposed, merely overlap.

The aperture in the cube of the telescope has also to be taken into account. The collimators besides being mutually opposed have to be exactly opposite this aperture: in practice they are not, and further portions of the object-glasses of the collimators are shut out from use by the cube of the telescope.

My belief then is that owing to faulty object-glasses the reading of A is determined wrongly, and as shewn before any error in the determination of A will be the exact amount that C_E will differ from C_W. If A_o in the Table is the *correct* value of A, but A_E and A_W are used in the formula for C_O, then C_E will differ from C_W by 8·2 divisions.

These experiments, however, practically left the question of the faultiness of the object-glass of the telescope untouched: in this matter there was still no proof, though there was evidence on which to form opinions. It was anyhow clear that if the object-glass of the telescope was to be tested, some other means must be devised than by collimators. At Dehra I took advantage of a distant meridian mark to abolish the collimators. I intersected the mark and took the micrometer reading several times, obscuring different portions of the object-glass of the telescope in turn. No constant difference between the readings, when different portions of the object-glass were obscured, could be detected, but these results did not deserve much weight as owing to the haze the observed mark was very unsteady and the observations very bad.

I finally decided that the best test to which to subject the telescopic object-glass was to take the reading of M with different portions of the object-glass obscured in turn. The telescope was thus pointed to the nadir, and the reading of the reflection in mercury of the centre wire taken, portions of the object-glass being obscured in turn. No difference whatever could be detected with telescope No. 1 in the reading of M, whether that reading were taken with the whole object-glass open, or with its eastern, western, northern, or southern half only.

All that has been written so far has only to do with No. 1 Telescope and its collimators. It was not till Lieutenant Lenox-Conyngham joined me in Dehra in April 1892, that we commenced experiments on his equipment, *viz.*, No. 2 Telescope and its collimators.

We first of all took the readings of A, D, and E in the same way as we had done with telescope No. 1. The readings of each shewed similarly large discrepancies when different portions of the object-glasses were obscured. As in the case of telescope No. 1, the discrepancies shewed that the object-glasses of both the collimators were certainly at fault, but we could not tell whether the telescopic object-glass was faultless or not.

To test the telescopic object-glass we took readings as before of the meridian mark, but were again prevented from attaching any weight to the results by the unsteadiness of

the image of the mark. Subsequent experiments, however, on the reflected image of wires in mercury seem to shew that the object-glass of No. 2 Telescope is by no means perfect. The results of these experiments are given in the following Table.

TABLE IV.—READINGS OF M.

M is the reading of the telescope micrometer when its direct and reflected images are coincident—

	Whole object-glass in use.	Northern half in use only.	Southern half in use only.	Western half in use only.	Eastern half in use only.
First set	1518·3	1517·9	1519·1	1519·0	1515·4
	18·5	17·3	17·3	19·5	16·6
	17·0	17·2	18·0	19·5	15·2
	17·5	18·0	19·0	19·8	14·1
	18·4				
Means	1517·9	1517·6	1518·4	1519·5	1515·3
Second set	1518·1	1519·0	1519·0	1521·2	1516·5
	17·8	19·0	18·5	20·4	16·4
	18·8	19·0	18·1	19·0	15·9
	18·9	19·0	18·9	20·0	16·5
Means	1518·4	1519·0	1518·6	1520·2	1516·3
General means	$M_O = 1518·2$	$M_N = 1518·3$	$M_S = 1518·5$	$M_W = 1519·9$	$M_E = 1515·8$

I may sum up the results of our experiments as follows:—

(1). However the collimators are set up, whether vertical, horizontal, or inclined, no change in C_o will occur and no difference between C_E and C_W be met with, provided the object-glasses of the two collimators and the collimating aperture are carefully aligned.

(2) If the collimators are not exactly opposed, or if the collimating aperture obscures portions of the object-glasses. C_E will be found to differ from C_W.

(3) If the collimators are slightly tilted, a change in C_o will occur, because fresh portions of the object-glasses become obscured by tilting.

(4) The former mysterious circuit errors were certainly caused by the observers not taking sufficient precautions in aligning their collimators.

(5) The faultiness in the object-glasses of the collimators belonging to either telescope is such as would cause errors of 8 divisions in the determination of C_o, if half the object-glasses of the collimators happened to be ineffective during the determination.

(6) The faultiness in the object-glass of No. 2 telescope might cause an error of 3 divisions in a reading, if half its area were obscured (which is impossible in practice).

(7) No signs of faultiness have so far been detected in the object-glass of No. 1 Telescope.

As stated previously the alignment of the collimators has never in practice been considered of any consequence so long as good vision of the wires was obtained, nor has any record been kept of their actual positions; it is, therefore impossible to correct old observations on account of errors from faulty alignment. It, however, fortunately happens that the adoption of a mean C_o (or of any value of C_o so long as it is the same for I. P. E. and I. P. W.) cancels all errors arising from faulty object-glasses of the collimators.

Experience has shewn that $\frac{C_E+C_W}{2}$ is a fairly accurate value of C_o, and I do not at present see any method of obtaining a more accurate determination. However C_E and C_W vary, and they can be made to vary easily through 6 divisions, the mean $\frac{C_E+C_W}{2}$ will be found to remain constant. Thus at Kurrachee in 1890, 5 values of C_E and C_W were taken as follows, the collimators being moved after each pair :—

C_E	C_W	Mean $= C_o$
1720·6	1724·3	1722·5
22·5	24·0	1723·3
25·8	22·1	1723·9
26·0	20·1	1723·1

Again at Waltair in 1891, C_E and C_W were determined once each on five successive nights, the collimators being wholly removed after each night's work, and set up again on the following night. The following were the results :—

C_E	C_W	Mean $= C_o$
1484·4	1473·6	1479·0
1482·2	1476·9	1479·6
1481·3	1477·8	1479·6
1484·8	1473·2	1479·0
1478·0	1482·3	1480·2

Again at Dehra in 1892 the same process was gone through four times with the following results :—

C_E	C_W	Mean $= C_o$
1512·1	1520·1	1516·1
1515·1	1516·7	1515·9
1515·5	1515·7	1515·6
1516·1	1514·8	1515·5

Extract from the Narrative Report of LIEUTENANT G. P. LENOX-CONYNGHAM, R.E., *in charge No. 23 Party, Astronomical, Season 1891-92.*

A new station for the longitude observations had to be selected at Calcutta, the old one having been destroyed at the time when the new Mathematical Instrument Office was built. Some little difficulty was experienced in finding a suitable site, and it was found necessary, in order to secure a view to the north, to build the pillars on the road which runs along the face of the Mathematical Instrument Office. The position is 32 feet 9 inches north and 31 feet 4½ inches east of the latitude pillar. There being no telegraph wire to the Survey Offices, a short length of special line had to be constructed for my use, starting from the Park Street telegraph office. This was readily undertaken and rapidly executed by the Telegraph Department.

All observers who have had occasion to level an instrument by means of reflection in mercury at Calcutta have complained of the extreme difficulty of getting a distinct image owing to the constant tremors of the soil. I was so fortunate as to have been provided with a new pattern of trough, the use of which entirely overcame the difficulty. A description of it may not be out of place.

The trough consists of a plate of copper about 9 inches in diameter and $\frac{1}{4}$ of an inch thick, the upper surface of which is slightly concave; the depth at the centre being about $\frac{1}{20}$th of an inch. To prepare it for use, a few drops of mercury are poured upon it and then rubbed over the surface with a rag saturated in dilute sulphuric acid. This process causes the mercury to amalgamate with the copper, and instead of remaining free, it, so to speak, wets the surface, and to a certain extent adheres to it; if now more mercury be added until there is a pool covering the plate, it will be found to have become more or less viscid, so that while its surface takes up a horizontal position quite as readily as in the ordinary trough, it is yet not liable to tremors. The pool of mercury is of course very shallow, so that a fairly level place must be prepared for the trough to rest on, but that is a very trifling disadvantage. As a matter of convenience, a gutter is cut all round the trough, near its outer edge, which catches any drops of mercury which may be spilled in filling.

So far as I am aware, all previous attempts to do away with the difficulty of obtaining a distinct image had been directed towards a more complete isolation of the trough from the surface of the ground,—springs, india-rubber buffers, floating vessels and the like being tried, but all without any effect; so that the originality of the invention under discussion, attacking, as it does, the mercury itself, and overcoming its liability to tremors, as well as its complete and unqualified success, render it well worthy of note. By its aid I was able to get as clear images of my spider lines while vehicles were passing within a hundred yards of my telescope, as I was at Kalianpur in 1889, where probably not a cart was moving within 10 miles, and I feel that I owe the inventor a heavy debt of gratitude.

The longitude station at Waltair is in the compound of the office of the Superintending Engineer, Public Works Department, which adjoins the Telegraph Office. The original station is marked by a stone bearing the letters $\frac{\text{IS}}{\text{GTS}}$ and surrounded by an iron railing. Owing to the erection of a small building close to it, the view to the north is cut off, and it was necessary to select a new station. This is 16 feet $4\frac{8}{4}$ inches west and 24 feet 2 inches south of the old one.

On the 10th of April both parties returned to recess quarters and commenced the computation of the season's work.

The results obtained were as follows :—

Arcs.		m. s.
Calcutta—Waltair	ΔL	20-9·194
Waltair—Jubbulpore	ΔL	13-28·501
Waltair—Madras	ΔL	12-16·868
Waltair—Bolarum	ΔL	19-11·525
Bolarum—Bombay	ΔL	22-48·785
Fyzabad—Dehra Dun	ΔL	16-20·704

These arcs complete the longitude work of India proper, and consequently the simultaneous reduction, by minimum squares, of all arcs measured, was undertaken.

It is satisfactory to note that the mean circuit error, taken from the equations of condition used in the reduction, amounts only to 0.04 of a second. The bulk of the work of the reduction was undertaken by Babu Kali Mohun Ghose, whose long experience of work of this nature rendered his assistance extremely valuable.

The health of the party was good throughout and, the members of it worked satisfactorily. Babu Hanuman Prosad proved himself an expert recorder.

As on previous occasions, every one connected with the Telegraph Department gave us the most cordial assistance.

TIDAL AND LEVELLING OPERATIONS.

Extract from the Narrative Report of LIEUTENANT-COLONEL J. HILL, R.E., *in charge No. 25 Party,—Season 1891-92.*

TIDAL OPERATIONS.

During the survey year under review, tidal observations, by means of self-registering gauges, were carried on at fourteen stations, namely, *Aden*, *Kurrachee*, Bhávnagar, *Apollo Bandar Bombay*, Prince's Dock Bombay, Cochin, Minicoy, Tuticorin, Trincomalee, *Kidderpore*, Akyab, *Rangoon*, Mergui, and *Port Blair*. The eight tidal stations whose names are not italicised are minor stations, where observations, as a rule, are taken for five years only. The six whose names are italicised are permanent stations, where the minimum period of observations lasts for nineteen years, and where observations should continue to be taken until the work at all the stations is completed. In addition to the automatic observations taken at the stations enumerated above, personal tidal observations to

graduated staves were taken daily, with the object of comparing the actual heights and times of high and low water with those predicted in the Tide Tables.

This was done at the following tidal stations, at all of which the tidal observatories are closed:—Cochin, Cocanada, Chittagong, Akyab, and Moulmein.

At Cochin, the tidal observatory was closed on the 20th March, and at Akyab on the 23rd May, six and five years' observations, respectively, having been completed at theses stations: the reason why an extra year's observations were taken at Cochin will be found in the description of the work of that observatory further on.

No new tidal observatory was established during the year.

It will be seen from the foregoing, combined with the particulars given in previous Annual Reports, that since the resumption of tidal operations systematically in 1877, observations have been taken at 31 tidal observatories, of which 19 (including Madras) have been closed on the completion of their registrations, and 12 are now in operation.

During the survey year 1892-93, tidal observations will be continued at the following stations, where they are now in progress, *viz*: Aden, Kurrachee, Bhávnagar, Apollo Bandar and Prince's Dock Bombay, Minicoy, Tuticorin, Trincomalee, Kidderpore, Rangoon, Mergui, and Port Blair; of which Tuticorin will be closed in June 1893, on the completion of the required series of tidal registrations. The resumption of tidal observations at Madras will, I hope, be permitted, and it is expected that tidal observatories will be opened at the four following new stations:—Muscat in Arabia, Bushire in Persia, Port Albert Victor in Kathiawar, and Diamond Island in Burma.

At Muscat, the preparations are complete, and I have arranged to send Mr. Belcham to start the tidal observations as early as possible in the ensuing field season. The tidal observatory clerk from Cochin will be in charge of the observatory.

At Bushire the masonry portion of the tidal observatory has been finished under the direction of Mr. R. H. New, Assistant Superintendent of Telegraphs, to whom my thanks are due for the great amount of trouble he has taken in carrying out the work under many difficulties. Mr. Belcham will proceed to Bushire to put up the tidal observatory and start the observations before proceeding to Muscat. In consultation with the Director of the Persian Gulf Section of the Indo-European Telegraph Department, I have arranged that the tidal observations shall be carried on in connection with the Reshire Telegraph Office, the observatory clerk's duties being performed by one of the telegraph employés, who will be supervised by the telegraph officer in charge My arrangements for Muscat and Bushire have been greatly facilitated by Mr. W. W. Squire, the Engineer to the Bombay Port Trust, who had the necessary timber observatory houses, float-cylinders, feed pipe, etc., made under his personal supervision and forwarded to their destinations; for which acts of kindness I feel very grateful to him.

At Port Albert Victor preliminary arrangements are in progress: the tidal observatory clerk will be appointed by the Bhávnagar State Engineer.

In my last Annual Report I mentioned that it was intended to commence taking tidal observations at Diamond Island tidal observatory which was then being constructed by the Executive Engineer of Bassein, who expected to finish it about the end of December (1891). The work, however, proved more difficult, tedious and expensive than he had anticipated, and when December came he estimated that it might be completed in March. In February he reported that there was great difficulty in the rock-cutting, and that no labour was to be had, except at exorbitant rates. Mr. Belcham, who selected the site in April 1890, revisited it finally in March and reported that "though the Executive Engineer has done his utmost to push on the work, by keeping his assistant on the island for weeks together and going down himself very frequently, I fear there is very little hope of the observatory being completed this season." In April Mr. Belcham reported that the work was stopped by bad weather, and that it could not be resumed until December (1892), that there only remained "some 20 feet of blasting to bring the excavation out of the rock," and that the Executive Engineer said "that the length of rock-cutting still remaining will not take long to complete when he once begins operations again." I hope this anticipation will be realised and that it will be possible during the coming field season to commence tidal observations at Diamond Island. The results derived from them cannot be combined or connected with, or assist our levelling operations; but I hope they will be useful to navigators and interesting to scientific theorists, and will more than justify the great labour and expense which will have been incurred in obtaining them. In my Annual Report for 1886-87 I stated that it seemed doubtful whether a tidal observatory would be established at Diamond Island, at the mouth of the Bassein River, as "the difficulty of communicating with it during the rainy season would probably neutralise its advantages." I hope that what I had in my mind then may not occur, and that the tidal observations may never break down during the heavy weather in the south-west monsoon, at which time I could not undertake to re-start them. The cost of the maintenance of the Diamond Island tidal observatory will be borne by the Bassein Port Fund, and it is proposed that the Diamond Island Telegraph Master shall perform the duties of tidal observatory clerk.

I shall now describe briefly the working of each tidal observatory, commencing with Aden and following the order of the stations round the coasts to Burma; including in this survey those stations where, in lieu of automatic tidal observations, personal observations to a graduated staff are taken daily in order to furnish comparisons between the actual and the predicted heights and times of high and low water.

Aden.—The last two annual reports on this important permanent station were very unfavourable. It is now a pleasure to me to be able to state that the tidal registrations have returned to their former satisfactory condition. The Port Officer's supervision of them is efficient, and the tidal observatory clerk is performing his duties correctly. The tide-gauge has worked almost uninterruptedly throughout the year. The longest break in its registrations was one of 50 hours' duration which occurred in July, and was due to the stoppage of the driving clock; another stoppage due to the same cause, but lasting only 6 hours, took place during the same month; and only one other slight mishap happened in June, when on one occasion the pencil failed to mark the tidal curve for 7 hours.

A new pattern tide-gauge with 'regulator clock' was substituted for the old one in May 1890. The clock rate from the first was not uniform, and the clock, as mentioned in my last report, was damaged through tampering with it in order to regulate it. Although the clerk has since then abstained from meddling unnecessarily with the clock, the time kept by it has not been regular.

It was therefore removed on July 25th, and a spare pendulum clock, sent from Poona, was substituted for it, with the result that excellent time has been kept ever since, and no failure of any kind has been reported. The auxiliary instruments have worked very satisfactorily, and their readings have been correctly taken by the observatory clerk. An inspection of the observatory was made by Mr Belcham between the 13th and 23rd May, when the instruments were all cleaned and put into working order. He reported that the piles supporting the observatory were found to be very much worm-eaten. I therefore, early in June, addressed to the Political Resident a request that he would take immediate measures to have them renewed, mentioning certain precautions necessary to secure the continuity of the tidal registrations.

I stated in my last report that one whole year's tidal registrations, except for the purpose of making a few comparisons between actual and predicted tides, had to be rejected. I am beginning to hope that so serious a gap in the hitherto unbroken series of years' observations may after all be avoided; and although I cannot say more in this report, I hope that in my next I may be able to state that my expectations have been realised.

Kurrachee.—At this station, which is one of the permanent tidal stations, the record of the year's work has as usual been very satisfactory—a fact due to the excellent arrangements of Mr. Morris, the Port Engineer, to whom my thanks are due for the efficient working of the observatory. There has not been a single break in the continuity of the tidal registrations during the year; and the record of the auxiliary instruments is almost equally perfect, one interruption only having occurred in the registrations of the anemometer in March, while that instrument was being repaired. I inspected the observatory in February, and found all the instruments in good order except the anemometer, several parts of which required renewal. I brought this to Mr. Morris's notice, and the instrument, which is the property of the Port Trust, was repaired under his direction during the following month.

During March and April, near the time of new moon, the tidal curve exhibited a peculiar distortion at high water springs.

On March 1st, the midnight tidal curve rose regularly until it attained a maximum height of 12·0 feet above the zero of the gauge at 11-30 P.M.; it kept at that height for 12 minutes and then fell until midnight exactly, by which time it had sunk 2 inches; it paused at this height for 25 minutes, and then began to rise again until it returned at 0-40 A.M. to its maximum height of 12·0 feet, at which it remained for 5 minutes, and then sank gradually and without further distortion towards low water. At the same time the barometer read 29·9 inches continuously; there was a high wind blowing from west-south-west, and the water at the tidal observatory was rough. New moon occurred two days previously, *viz.*, on February 28th at 8-15 A.M. The other abnormal curves of which I now give the particulars were very similar.

On March 29th the first pause of the tidal curve at the maximum height of 12·0 feet above zero of gauge lasted from 10 P.M. to 10-10 P.M.; its next pause after falling 3 inches lasted from 10-50 to 11-10 P.M.; its last pause after rising again to the maximum of 12·0 feet lasted from 11-35 to 11-40 P.M. The barometer remained at 29·8 inches. There was a brisk gale from south-south-west, and the water at the tidal observatory was rough. New moon occurred on March 28th at 5-46 P.M.

On April 27th the first pause of the tidal curve at the maximum height of 12·0 feet above zero of gauge lasted from 9-25 P.M. to 9-30 P.M.; its next pause after falling 2½ inches lasted from 10-20 to 10-40 P.M.; its last pause after rising again to the maximum of 12·0 feet lasted from 11-5 to 11-15 P.M. The barometer remained at 29·9 inches. There was a brisk gale from south-south-west, and the water at the tidal observatory was rough. New moon occurred on April 27th at 2-14 A.M.

On the following day, April 28th, there were two of these abnormal registrations. During the first, the tidal curve first paused at the maximum height of 12·0 feet above zero of gauge from 10-40 A.M. to 10-50 A.M.; its next pause after falling 3½ inches was from 11-30 to 11-45 A.M.; its last pause after rising again to the maximum of 12·0 feet was from 0-25 P.M. to 0-30 P.M. The barometer remained at 30 inches. There was a brisk gale from the south-west, and the water at the tidal observatory was rough. During the second, the curve first paused at the maximum height of 12·0 feet above zero of gauge

from 10-20 P.M. to 10-40 P.M.; its next pause after falling 1-inch was from 10-57 to 11-2 P.M.; its last pause after rising again to the maximum of 12·0 feet was from 11-5 to 11-35 P.M. The barometer remained at 29·9 inches. There was a brisk gale from the south-west, and the water at the tidal observatory was rough. No other tidal curves similar to those just described occurred during the year, nor have I any record of any like departure from the normal type of tidal curve at Kurrachee during past years. I may remark that the maximum height of 12 feet above the zero of the gauge, which is so noticeable in the foregoing descriptions, happens to be about the maximum for the whole year under report. It has been exceeded, however, in other years in several instances; but on such occasions the tidal curve was regular, whereas in the instances just described the curve was depressed just at the time when highest water was expected.

The peculiarity that all these abnormal curves attained a maximum of 12 feet above the zero of the gauge instead of rising above that height, as they would have done had they remained regular, seems to point to something faulty in the mechanism of the tide gauge, such as a lowering of the counterpoise weight of the float or a shortening of the counterpoise chain of the float band; but nothing of this nature has been reported or is known to have occurred The first three abnormal curves passed without notice in the tidal observatory; but the clerk noted the last two in his daily reports for the 28th and 29th April, and attributed their distortion to "imperfect communication;" he also submitted measurements of these tides, which he stated were taken to the observatory graduated staff at intervals of 5 minutes about the times of high water, and which exhibit the tide rising above the 12 feet limit in a normal manner. An inspection of the curves negatives the idea that there was imperfect communication, and certain peculiarities of the clerk's staff measurements throw some doubt on their authenticity, and they cannot at present be accepted. The next inspection of the tidal observatory ought to be made before the time when, according to calculation, the tide will rise again to the height of 12 feet above the zero of the gauge. It will then, I hope, be possible to discover the true explanation of these abnormal curves.

Bhâvnagar.—At this station, the tidal registrations may be said to be satisfactory on the whole. During the first four months of the survey year the rules regarding the flushing of the cylinder were not properly observed, but since February there has been greater regularity in this respect, although there is still room for improvement. The cylinder ought to be flushed once a fortnight, but during the last three months of the year under report this duty has been performed only four times. In addition to the unavoidable interruptions to the tidal registrations so caused, there were a few short interruptions due to slight accidents to the communication pipe and air-cock, to the pencil failing to mark, and to the stoppage of the driving clock; but in all these cases the broken curves were easily completed by interpolation. The Bhávnagar tidal observatory clerk requires close and careful supervision. Some of the interruptions I have referred to were not only not reported by him, but he attempted to conceal them. In my last Annual Report I mentioned that the self-registering aneroid barometer had been working imperfectly: it continued to do so until January, when I inspected the observatory. The instrument in question and a mercurial barometer, both the property of the Government of India, were set up at Bhávnagar during an inspection of the tidal observatory in August 1890 by Mr. Wood, who took the aneroid and mercurial barometers belonging to the observatory to Poona for repair. The latter instruments, which for some time had been working well at Poona, were replaced in the observatory during my above-mentioned inspection, and their substitutes removed, with good results at first; but soon the repaired aneroid returned to its former unsatisfactory state, and its records are practically worthless. The readings of the standard mercurial barometer, however, which are taken daily at 7 A.M., 10 A.M., 4 P.M., and 6 P.M., are complete for the year, and partially supply the necessary barometric information. The anemometer has worked very satisfactorily throughout the year.

My inspection of the tidal observatory in January, already referred to, took place towards the end of that month, when the tide gauge and anemometer were cleaned, and certain of the auxiliary instruments were removed and replaced by others, as already mentioned.

I am indebted to Mr. Procter-Sims for his cordial co-operation, which has secured the success of the tidal operations in Bhávnagar. My thanks are also due to his Nautical Assistant, Captain F. M. Godrich, to whom he has entrusted the supervision of the tidal observatory, and who takes a great interest in the work.

Apollo Bandar, Bombay.—At this most satisfactory tidal observatory the tide-gauge has worked uninterruptedly throughout the year.

In my last annual report I mentioned that I had recommended the removal of the graduated staff used for comparing the level of the water outside the cylinder, with the level of the water within it as indicated by the tide-gauge, and the substitution for the graduated staff of another of a different construction. This has been done; but the new graduated staff is only working experimentally as yet.

The observatory was inspected by me in January, when the gauge was found in very good order apparently. On testing its balance, however, before cleaning it, the preponderance on the float side was found to be in defect, which pointed to a breakage of the counterpoise chain on the float side. On dismantling the instrument, it was found that the counterpoise chain had corroded and parted near the float, and a length of 15 feet of chain had to be renewed.

Auxiliary instruments are not employed at either of the Bombay tidal observatories, as the necessary meteorological observations are taken at the Colaba Observatory.

Prince's Dock, Bombay.—The small scale tide-gauge with upright recording drum, which has been at work for four years at this observatory, continues to supply very satisfactory records on the whole. The few short interruptions and irregularities in the registrations which occurred during the year are not in any respect the fault of the observatory clerk, but are due to slight imperfections in the design of the instrument. The interruptions referred to were caused by the float band sticking to the studs of the stud-wheel, and the other faults consisted in the zero pencil piercing and tearing the diagram paper, and in the latter twisting at the top on one occasion.

In former Annual Reports mention has been made of the twisting of the diagram paper, of interruptions caused by the float band sticking on the stud wheel by the breakage of the float band, the stoppage of the clock, etc. I inspected this observatory in January, and on that occasion made the following remarks on the design of the tide-gauge in the observatory inspection book: —

As the float band is a very long and thin copper ribbon, it is apt to twist. Much inconvenience is caused by the tearing of the diagram paper by the zero pencil. The arrangement of this pencil must be changed. Its position is between the recording drum over which the diagram paper passes and the cylindrical roll from which that paper unwinds. It therefore acts on a part of the paper which is not supported behind. As the unwinding roll pays out the paper, the diameter of the roll diminishes, and the unsupported surface of the paper comes gradually forward and presses more and more on the point of the zero pencil, until at last a tear is made. This pattern of tide-gauge appears inferior to that in general use at Indian tidal observatories (Newman's pattern with long horizontal drum). It is more complicated and liable to get out of order. It is not so easily cleaned. The scale on which it registers the tidal curve is small and cannot be changed. The float band, pencil wire and some other parts are too frail. There is no arrangement for adjusting the height of the curve-recording pencil; so that setting to zero is both troublesome and tedious. Measurements cannot be taken from the diagram while the instrument is working, as may often be desired. Interruptions to the registrations, damage to the diagram paper, such as tears caused by the zero pencil, etc., may not become known until the paper is removed, for the faulty or damaged parts may have been rolled up on the receiving cylinder and have become concealed during the absence of the clerk from the observatory.

At the same inspection I left directions regarding the fitting of a simple contrivance to hinder the float-band from twisting, and I attached to the gauge a new zero pencil-holder designed specially to avoid tearing the diagram paper.

I am much indebted to Mr. W. W. Squire, the Engineer to the Port Trust, for the assistance he has given to the tidal operations at both of the Bombay observatories. In many other ways also he has helped us in our operations from time to time, and I feel very much obliged to him.

Cochin.—At this station the tide-gauge has worked very satisfactorily; its registrations having been continuous throughout the year, with the exception of three short interruptions, none of which lasted longer than 8 hours. The registrations of the aneroid and anemometer have also been very satisfactory. Those of the former were continuous, except for 2 hours, on the 20th November, while those of the latter were absolutely uninterrupted.

In the appendix to the General Report for 1886-87, page xxxii, it was mentioned that an unexpected accumulation of sand formed near the observatory and embedded the rose of the communication pipe, thus preventing the free passage of the water in and out of the cylinder and rendering the registrations inaccurate. The curves were inaccurate and interrupted from the 4th April to the 26th May 1887, and for this reason it was thought desirable to continue the observations for one year beyond the usual period. Six years' observations were completed on the 3rd February, and the observatory was inspected and then dismantled and closed by Surveyor Dhondu Venayak on the 20th March, who before leaving Cochin packed all the instruments carefully and left them in charge of the Port Officer for transhipment, when required, to Bushire, and attached a graduated staff of the usual pattern to one of the outer piles of the Port Officer's jetty. Since the removal of the tide-gauge, tidal readings to this staff (the zero of which coincides with that of the Tide Tables) are being taken daily under the Port Officer's direction, who sends them to my office monthly, compared with the corresponding predictions given in the Tide Tables. Captain Winckler, the Port Officer, has had the kindness to supervise the tidal observatory at Cochin during the whole time that it remained open, and during that period of more than six years his interest in the work and his willingness to assist it could always be relied on. The monthly comparisons he is now sending to my office are most useful, and I feel greatly obliged to him for his long-continued co-operation.

Minicoy.—At this station the tide-gauge worked most satisfactorily, the only accidental interruption to its records being one of 6 hours, when the pencil was out of adjustment. The clerk also stopped the gauge on two occasions to flush the cylinder, the unavoidable interruptions so caused lasting in the first instance 1 hour 51 minutes and in the second 50 minutes only.

The aneroid observations experienced only two short interruptions, one of 12 hours' and the other of 20 hours' duration.

The anemometer also worked very satisfactorily. On one day the spirals, owing to their not being sufficiently lowered, failed to mark the diagram. The only other interruption to the observations occurred during stormy weather, lasting from the 1st to the 5th November. This began at 10-30 A.M., November 1st (the date of the Port Blair cyclone), the wind blowing from the north at about 33 miles an hour (barometer 30 inches), and keeping at that velocity until noon. The wind then increased to 50 miles an hour, and

blew at this strength from the north-east until 4-50 P.M., when it slackened to 30 miles an hour (barometer 29·9 inches). At 6-45 P.M. the anemometer clock stopped (presumably from oscillation caused by the wind), and the registrations were suspended until 9 A.M. next morning, when the clock was re-started. From this time until 9-30 P.M. the wind was blowing from the north-north-east with a velocity of 30 miles an hour (barometer 29·7 inches); it then increased to about 55 miles an hour, and while maintaining this velocity changed its direction gradually until it blew from south-east by south at 4 A.M., November 3rd. The wind then began to drop, and at 8 A.M. its velocity was 25 miles an hour (barometer 29·9 inches), from which it fell to about 12 miles an hour, its direction being still from south-east by south. On the following day (November 4th) the wind was from the south-south-west at 2 P.M.; it then freshened and continued its change of direction until at 4 P.M. it was blowing from the south-west with a velocity of 30 miles an hour. It maintained this strength and direction until 8 A.M. on the 5th, when it began to decline, and gradually fell to 12 miles an hour, the barometer all the while reading between 29·9 and 30·0 inches. During this stormy weather the tide-gauge worked perfectly well, and the tidal curves showed no irregularity; there was only a slight sea at the tidal observatory, which is situated within the lagoon, except on November 2nd, when, according to the clerk's report, the sea was very rough and 4·01 inches of rain were registered. The rainfall the preceding day was 5·53 inches, and the day before that 2·49 inches, and the clerk reported that the rain flooded the lower parts of the island to a depth of from 3 to 4 feet, and the storm destroyed many trees and houses, but no lives were lost.

I mentioned in last year's report that meteorological records are sent by the clerk to the Meteorological Reporter to the Government of India. He gained much credit for the observations he took all through the stormy weather just mentioned, and received from the Meteorological Reporter a reward of R20.

I inspected the tidal observatory from the 6th to the 11th December, having, through the courtesy of the Director of the Royal Indian Marine, obtained a passage to Minicoy and Ceylon in H. M.'s I. M. S. "Investigator," commanded by the late Commander R. F. Hoskyn, R.N., then in charge of the Marine Survey of India. I found the site of the tidal observatory well chosen, the observatory well built, and that all the instruments had worked very satisfactorily; but water had collected at the bottom of the anemometer shaft, and the clerk received orders to examine the instrument periodically and keep it free from water. As stated in my last report, the anemometer is set up about a mile north of the village, where there is an open space free from trees; it is about 2 miles north of the tidal observatory, and this is rather an inconvenient distance. It would be an improvement to have a strong braced stand, 60 feet high, near the observatory to carry the anemometer, which would then receive the wind unobstructed by the trees; and if a favourable opportunity should present itself, I shall have this done according to plans already prepared in my office. But as there are two tidal observatory clerks at Minicoy (*vide* appendix to General Report for 1890-91, page xv) the inconvenience of the present arrangement is much less than it would be if only one were employed. The clerks were found to be proficient in their duties, including all the chronometer and clock comparisons. The comparisons made between the standard sun-dial and the chronometer show that the rate of the latter is very uniform and agrees well with Mr. Belcham's original determination. We are greatly indebted to Lieutenant Channer, R.N., the Superintendent of Light-houses, for his continued assistance in bringing away the records and reports from the observatory, and carrying letters, etc., to the clerks, at his periodical visits to the island.

Our thanks are also due to the Collector of Malabar for the arrangements he made for the comfort of the observatory clerks by building a substantial house for their accommodation, which was approaching completion at the time of my inspection, and which has since then been finished and handed over to us at the small rental of R2 a month.

Descriptions of the Island of Minicoy will be found in—

(*a*) Captain Basevi's narrative report printed in the appendix to G.T.S. General Report for 1869-70.

(*b*) My narrative report contained in the appendix to this Department General Report for 1890-91.

(*c*) The Malabar Manual.

(*d*) An article in two parts by W.L., entitled "Minicoy: the Island of Women" in Blackwood's Edinburgh Magazine for February and March 1889, pp. 197 and 307.

(*e*) A series of four unsigned articles in *The Times of India* newspaper of the 2nd, 9th, 23rd, and 30th June 1892, entitled "Memorials of a Maritime Microcosm," the writer of which mentions incidentally that he was one of our party on board the "Investigator."

Tuticorin.—The working of the tide-gauge at this station has been perfect throughout the year, no interruption to its registrations having occurred. The aneroid also worked uninterruptedly, and the barometric diurnal variation is correctly shown on all the diagrams. The anemometer worked satisfactorily until November 4th, when the direction of the wind began to be registered incorrectly. The clerk then noticed that the endless screw of the steering-vanes was much worn away, and its condition got worse and worse until, on the 16th of the same month, the direction of the wind was not marked at all. A new endless screw was fixed to the instrument on the 30th March (during the inspection of

the observatory), and since then no failures of any kind have been reported; but although the records of the direction of the wind are thus incomplete, its velocity has been continuously registered during the whole year. The observatory was inspected by Surveyor Dhondu Venayak from the 29th March to the 1st April, when all the instruments were cleaned and left in good working order. Our thanks are due to Captain Baker, the Port Officer, for his continued supervision of the observatory.

In last year's Report I mentioned that during the spring-tides towards the end of June, which were accompanied by strong south-west winds, the water fell to a remarkably low level. I have now to notice an equally remarkable circumstance that occurred during neap tides on the night of the 11th and morning of the 12th October. On the former date the wind, which had been blowing gently, at the rate of about 5 miles an hour, from S. E. by S., changed to E. and began to blow from that quarter at a velocity of over 20 miles per hour at about 10 P.M., which was the time of low water. The tide rose for about an hour and a half, at an ordinary rate of about 1½ inches an hour, and then in the space of an hour rose rapidly through a further height of 1 foot, attaining at 0-40 A.M. of the 12th a height of 2 feet 9 inches above the zero of the gauge, or a height of about 11 inches above its proper level. After this the wind began to drop, and the tide fell in an hour to a height of 1 foot above zero, thus sustaining a sudden fall of 1 foot 9 inches at a place where the mean yearly range of the tide is less than two feet. After touching the depth just mentioned the tide rose again with a rapidity about equal to that of its abnormal fall, and resumed its interrupted motion, while the wind moved southwards and fell to a gentle breeze.

I should like to correct here a clerical error in the paragraph at the end of the notice of the Tuticorin tidal observations, contained in my last Annual Report. When bringing to notice a peculiarity of the tides in the Gulf of Manar mention was made of the "south-east monsoon." This of course should have been the *north-east* monsoon, during which, contrary to what might be expected, the general level of the sea is considerably higher than during the south-west monsoon.

Trincomalee.—At this station there have been only three short accidental interruptions to the registrations of the tide-gauge, two caused by the pencil failing to mark the diagram, and a third by a stoppage of the driving clock. This stoppage, which occurred on the 23rd July, prior to which the rate of the clock had been regular, lasted 19 hours, during 7 of which tidal records were supplied by means of observations to the graduated staff. Being unable at the time of the stoppage to obtain telegraph time, the clerk first set the clock by the anemometer clock, and afterwards tried to correct it by the aneroid clock. On the afternoon of the 26th he obtained telegraph time and set the clock, but found it 7 minutes slow the next morning. He appears to have been either unable to set it properly, or to keep it to right time until the last day of the month, since when the rate of the clock, as checked by telegraph time, has remained satisfactory.

The aneroid has worked continuously throughout the year, and the barometric diurnal variation is well shown on all the diagrams.

The record of the anemometer experienced seven interruptions, each lasting about a day. They were due to ordinary accidents, such as the breaking of the cord of the clock weight, the stoppage of the clock, and the insufficient lowering of the recording spirals.

I inspected the observatory from the 20th to the 24th December and found the instruments in good order, with the exception of the anemometer, which was so clogged with coal dust that the rate of the clock was retarded two hours daily. The present position of the anemometer on top of the tidal observatory is not a good one, as it is not exposed to the free action of the wind, and it is impossible to keep it clean owing to the coaling which goes on in the vicinity. I have therefore arranged to remove the instrument to the highest point of Fort Ostenburg immediately above the Naval Store Yard. It will be put up in a small wooden house that is now being prepared, and its removal to the new site will take place at the next inspection.

The present clerk, who was appointed on the 23rd March 1891, was examined in his duties and found to understand and perform them well. There could be no doubt that the Telegraph Department at Colombo were not in the habit of telegraphing Madras time to Trincomalee with sufficient regularity or correctness for our purposes, and I therefore propose to put up at the observatory one of Colonel G. Strahan's standard sundials, so as to be independent of telegraph time. During the inspection Captain Paterson, R.E., very kindly obliged me by photographing the aneroid with its clock face removed, and gave me the negative, which I sent to Mr. Eccles at Dehra Dun, to enable him to prepare a plate of the instrument, which is of Légé's newest pattern, for the Tidal Volume.

Mr. De Ridder, the Naval Store-keeper, supervised the observations until the 29th February, on which day Mr. Millett took over that duty, and our thanks are due to both for their assistance and their interest in the work.

During the north-east monsoon the weather on the east coast of Ceylon is not favourable for making tidal observatory inspections. When I inspected the Trincomalee observatory in December, my work was much impeded by constant and heavy rain; but having obtained a passage in H. M.'s I. M. S. "Investigator" to Minicoy and Ceylon, I did not like, after being landed at Colombo, to leave Ceylon without inspecting the Trincomalee observatory. I was advised not to travel from Colombo to Trincomalee by the land route, as, owing to the rain, the roads were at the time nearly impassable, and the journey would probably have taken several days, which would have been passed in great discomfort.

I therefore went by sea in the coasting steamer, the "Lady Havelock," and arrived at Trincomalee in a little less than three days. I had arranged with Captain Hoskyn that the "Investigator" should take me on to Madras when my work was finished at Trincomalee; but owing to the cholera, which was severe at the latter place, she was not allowed to run the risk of touching there, and I therefore availed myself of a B. I. S. N. Co.'s steamer, the "Rajputana," and was taken in her *viâ* Jafnapatam to Negapatam, where I landed, and whence I proceeded by rail to Madras. Owing to bad weather the journey from Trincomalee to Negapatam lasted for the greater part of four days, a considerable time being spent at anchor, waiting for the weather to clear sufficiently to allow land-marks to be recognised. During the north-east monsoon navigation along these coasts is often difficult, for, owing to the shoals, it is necessary to see land in order to steer correctly. The Commander of the "Rajputana" told me that conspicuous pagodas, which would be excellent marks for determining a ship's position if they were shown on the Admiralty charts, are not entered on them, and my own experience of the latest charts of the north-east coast of Ceylon I have been able to obtain, goes to prove that they require revision and bringing up to date. The best month for visiting Trincomalee is February.

Madras.—I arrived in Madras on December 30th, and left for Poona on the following day. On the day of my arrival I saw the Chief Engineer and Secretary to Government in the Public Works Department, and explained to him my views regarding the resumption of tidal observations at this port. He promised to try to arrange the matter with the proper authorities if I sent him copies of the necessary letters. I did so, adding suggestions as to where and how the observatory should be built; but as yet I have nothing further to report regarding the matter.

Cocanada.—Since this station was closed in 1891, tidal observations at high and low water have been taken daily during daylight to a graduated staff, under the superintendence of Captain Wicks, the Port Officer, to whom I am much obliged for his kind co-operation. During spring tides on September 21st and 22nd, the actual heights of the tide so measured were considerably higher than those predicted in this year's Tide Tables. The greatest discrepancy was at low water on the afternoon of the 21st, when the actual height exceeded the predicted by 2 feet 1 inch. This is a considerable difference at a station where the mean range of the tidal springs is 5·2 feet. Captain Wicks in his report on this subject attributed the abnormal height of the water to a storm the centre of which on these days was close to the coast south-east of Cocanada, and moving slowly westwards, according to telegrams received from the Meteorological Reporter to the Government of Bengal.

Kidderpore.—At this station there have been only 3 interruptions to the tidal registrations during the year. The first, which occurred in November, was a trivial one of less than 3 hours' duration due to the vibration of the observatory stopping the driving-clock of the tide-gauge. The other two occurred in consequence of the absence of the clerks through illness; the first of the interruptions so caused was on the 22nd and 23rd December and lasted 30 hours; the second was on the 9th and 10th August and lasted 18 hours. Kedar Nath Das, who had been the observatory clerk ever since the tidal observations were commenced in 1881, fell ill on December 20th, and was relieved by the present clerk, Sarada Prasad Das, on December 23rd, who had been clerk at the Dublat tidal observatory up to the time of its destruction in 1886.

The aneroid worked continuously until June 16th, when it had to be sent to the Mathematical Instrument Office for examination and repair. It was brought back and set up on July 7th, since which date no failure of any kind has been reported. For the time the aneroid was not at work the readings of the standard mercurial barometer taken daily at 7 A.M., 10 A.M., 4 P.M., and 6 P.M., partially supply the necessary barometric information. The anemometer, like the tide-gauge, had its registrations interrupted twice while the clerks were ill: otherwise it has worked most satisfactorily. The observatory was inspected by Mr. Belcham from the 21st to the 26th April. He found the instruments, especially the anemometer, to be very dirty, and before leaving had them cleaned thoroughly and put into proper condition. He reported that the observatory was in good order, and that it had been recently connected by a substantial wooden bridge with the wooden pier on the west side of the new dock, with the result that it is less liable to oscillation now than formerly. He also reported that the present clerk knows his duties thoroughly, but that he had not kept the instruments sufficiently clean; and that he warned him to take more care of them in future.

My thanks are due to Lieutenant Petley, R.N., the Port Officer, who continues to supervise the working of the observatory.

Chittagong.—Since this station was closed in 1891 tidal observations at high and low water have been taken daily during daylight to a graduated staff under the superintendence of Mr. Good, the Port Officer, to whom I am much obliged for his kind co-operation.

Akyab.—At Akyab the tide-gauge has worked most satisfactorily, and practically without interruption, during the year under report, the only flaws being two short stoppages of the clock, each of two hours' duration only. The auxiliary instruments also have worked very satisfactorily, only one short stoppage of the aneroid clock and two short stoppages of the anemometer clock having occurred during the same period. Two inspections of the observatory were made. The first was a hasty inspection made by Mr. Belcham on April 15th, while the steamer in which he was travelling stopped at Akyab. He found

everything in good order. The second and final inspection was on the occasion of closing the tidal observatory on the completion of its period of observations. This period terminated on May 15th. Surveyor Dhondu Venayak was directed to close the observatory. After inspecting all the instruments, which he found clean and in good working order, and taking the necessary levels, measurements, and tests, all of which proved satisfactory, he dismantled the instruments on May 23rd, and after packing them carefully in their cases left them in charge of the Port Officer, who has stored them in the Custom House godown until such time as I may require them. While the observatory was being closed, a new graduated staff, divided to feet and inches, was set up at the north-west corner of the T head of the iron pier, its zero being made to coincide with the datum of the Tide Tables.

Observations to this staff are taken regularly twice a day during daylight under the direction of Captain Pryce, the Port Officer, who sends them to my office. My thanks are due to him not only for his kindness in this respect, but for the great interest he has always evinced in the tidal operations.

At the time when Surveyor Dhondu Venayak left Akyab after closing the tidal observatory, the two bench marks of reference (A and B) were in good preservation.

It is very satisfactory to be able to state that from the commencement to the close of the 5 years' period of tidal observations at Akyab no interruption of any importance occurred in the working either of the tide-gauge or of the auxiliary instruments. This is very creditable to the observatory clerk.

Rangoon.—At this station the registrations of the tide-gauge have been most satisfactory throughout the year. Only one unimportant interruption occurred on the 6th March, when the pencil failed to mark the diagram. The registrations of the aneriod have been fairly continuous, but unfortunately they are worthless, for the diagrams shew no automatically registered diurnal variation during the whole year, thus proving the insensitiveness of the instrument. The readings of the mercurial barometer taken at 7 A.M., 10 A.M., 4 P.M., and 6 P.M. daily are, however, complete. The record of the anemometer is not very satisfactory. Its registrations suffered the following interruptions :—One of fourteen days in January, while the driving clock was being repaired ; another of five days in June, while a new endless screw for attachment to the steering-vanes was being made to replace the old one, which had broken ; and four minor interruptions, which occurred in the months of October, December, March, and August, and which were all due to the stoppage of the driving-clock. The record for the 10th March is also missing, owing to that day's diagram having been stolen.

The auxiliary instruments are still at work in the positions specified in last Annual Report, but they will be removed, when the necessary data can be supplied from the meteorological observatory, which, as I remarked, was being constructed in the compound of the Port Engineer's Office.

The observatory was inspected by Mr. Belcham in February, who reported that the lower bracing of the piles, mentioned in last Report as being incomplete, had been completed, with the result that the observatory has become more stable ; but there is still a little oscillation, which, though not sufficient to interfere with the working of the tide-gauge "regulator" clock, caused the "pendulum" clock of the aneroid barometer to stop occasionally. During the inspection the instruments were thoroughly cleaned and all put into good working order, with the exception of the aneroid, which, although it was fitted with a new hair-spring and attended to constantly by the assistant mechanic who accompanied Mr. Belcham, could not be restored to its former state of efficiency.

My acknowledgments are due to Mr. Darlington, the Vice-Chairman of the Port Commissioners, and to Mr. Reichenbach, the Port Engineer, for their continued assistance and the interest they take in the tidal operations.

Until recently there were almost inappreciable differences between the datum lines in use in Rangoon These small differences are now adjusted, and all heights will consequently be referred to Graham Smith's datum, which corresponds to the zero of the tide-gauge, to the zero of the graduated staff at Brooking Street wharf, to "low water of spring tides of the dry season (December to April)," the Marine Survey of India datum for Rangoon, and to the datum of the River Surveyor's charts.

Moulmein.—This tidal observatory was closed in April 1886, ever since which time Captain Dodd, the Port Officer, has had the kindness to send me monthly, with the greatest regularity, statements of the actual times and heights of the tides observed daily under his direction, compared with the predictions contained in the Tide Tables. The last of these statements received from him refers to the month of August 1892; in the letter accompanying it he says: "I would beg to point out that the great difference between the actual and predicted low water tides for nearly the whole of the month must be due to the almost entire cessation of the rains, which during August is most unusual, while the total rainfall to the end of August has been much below (some 27 inches) the average of the past 10 years." The statement he sends shows that at low-water in August 1892 the predicted height of the tide was invariably higher than the actual height, the minimum discrepancy being 1 foot 5 inches, the maximum discrepancy 4 feet 2 inches, and the average discrepancy 3 feet. I believe the large errors in the predictions to be partly due to the cause assigned by Captain Dodd; but I believe them to be also partly due to the comparisons contained in his statements not having been sufficiently brought into use to modify the August group of observations for the years 1880 to 1886, on which the

predictions for August, contained in the Tide Tables depend—*vide* preface to the Tide Tables for the Moulmein River for 1888. It will be seen from the following table that since 1886, the predicted heights of the tide at low water have, during every August without exception, been in excess of the actual heights:—

			Ft.	In.
1887	August	Average excess	1	10
1888	„	ditto	0	2
1889	„	ditto	2	2
1890	„	ditto	1	9
1891	„	ditto	2	2
1892	„	ditto	3	0

Mergui.—At Mergui the tidal registrations may be considered satisfactory as there were no serious interruptions to them during the year. The interruptions that occurred were as follows: three caused by the stoppage of the tide-gauge driving-clock, and lasting 20, 12, and 5 hours respectively, six lasting from 1 to 5 hours, caused by the breakage, through corrosion, of the counterpoise chain of the float band, and 16, lasting from 1 to 7 hours, caused by the failure of the pencil to mark the diagram.

The last-mentioned species of failure would appear to be due to the observatory clerk not having kept the inside of the pencil-holder sufficiently clean and smooth.

The aneroid barometer worked steadily, with but one interruption, until February 28th, when the bar connecting the driving-clock with the drum got out of gear and prevented the drum from revolving. This was set right during the inspection of the observatory (which took place in the following month) since when no failure has been reported.

In the record of the anemometer there were twelve interruptions, lasting from 7 to 24 hours, caused by the stoppage of the driving-clock. This instrument was cleaned and regulated during the inspection in March, and no more stoppages occurred.

In January Mr. C. Wood, to whom I am much obliged for his thoughtfulness, wrote to me saying he would be in Mergui about the end of the following month and kindly volunteering to take the error of the tidal observatory chronometer and compare it with the standard sun-dial. After arriving at Mergui he took time observations with his theodolite on February 20th and 21st, and found that the observatory time on the former day was 17 minutes 15 seconds fast of local mean time, which has necessited a proportional correction to the time lines on the tidal diagrams for a whole year. The accumulation of this large time error is not creditable to the observatory clerk, who persistently neglected to compare his chronometer with the standard sun-dial, which Mr. Wood found in its box, covered with cobwebs. The clerk does not appear to have even taken the trouble to ask any one at the port for the correct time.

The tidal observatory was regularly inspected by Mr. Belcham in March, when the tide-gauge, aneroid and anemometer were cleaned and attended to in every particular; and the float-band having corroded to about half its original thickness, and the counterpoise chain being in two pieces and very weak, they were replaced by new ones.

At the same time the accurracy of the setting of the standard sun-dial was tested by comparing the mean time obtained from its readings with the mean time obtained from observations to the sun with a theodolite, with the result that its time was found to be 3½ minutes slow. The standard sun-dial was adjusted accordingly, and the clerk was reinstructed in the method of finding correct mean time from it. His observations since then have been taken, as a rule, every fortnight and submitted to my office, and they show that the tide-gauge clock is being kept to correct time.

I am indebted to Mr. Batten, the Deputy Commissioner of Mergui, for kindly continuing his supervision of the observatory.

Port Blair.—I was able to give a favourable notice of this tidal observatory in my last Annual Report. When I wrote it, everything was going on very satisfactorily, and we had every reason to hope for a continuance of that pleasant state of things. But on November 12th, 1891, I received the following communication from Mr. Brookes, the Port Officer, dated the 4th of the same month:—

"I have the honor to report that this Settlement was visited by a most violent cyclone, which took place on Sunday, the 1st, and Monday, the 2nd instant. It began from the north-east and veered round to the southward early on the morning of the 2nd. The severity of the storm was so great that not a house or tree on the Island escaped damage. Great destruction and loss of life took place on the northern and southern districts, and H. M.'s I. M. S. "Enterprise" was totally lost, all her officers and crew being drowned with the exception of six natives, who were thrown on shore at South Point. I regret to have to report that the tidal observatory has suffered in the storm. The brick wall was washed away and the drum was displaced and carried away by the sea. All the instruments in the observatory have been injured, and the anemometer on the European Infantry Barracks destroyed. All operations have been stopped, and the whole observatory will have to be put up *de novo*, and this can only be done by your department. I have learnt that the drum of the observatory has been washed ashore at North Bay and is saved: of course all the records in the building have been lost. I am told that the last observation taken at the Ross Hospital shewed a force of 245 miles an hour. You can form some idea of the destructive nature of the storm, when I tell you that the dense forest appears as if burnt out by fire, nothing left standing but the stems of the arge trees, all the branches having been blown away."

On receiving this report, I addressed a letter to the Chief Commissioner of the Andamans, asking when it would be convenient to him to have the observatory re-erected,

and I made arrangements for sending a complete set of instruments and a float cylinder to Port Blair.

He replied that the observatory would be ready before the arrival of the mail steamer, which was timed to leave Calcutta for Port Blair on the 1st of January. I therefore sent Mr. Belcham by that steamer, and he, and the float cylinder (which had been made in Calcutta), and the instruments reached Port Blair on the 4th of January. He set to work immediately on landing, and the following is his report on his operations :—

"I found the tidal observatory and the tide-gauge were seriously damaged, and the aneroid barometer, the anemometer, and all the diagrams between the 21st September and 1st November were totally destroyed. Strange to say, the mercurial barometer, which was fixed to one of the posts of the observatory, remained undamaged, although it was made very dirty by being drenched with sea water. The rain-gauge, though much battered, was still repairable. The parallel bars of the tide-gauge had been wrenched off, and the drum, float, and float cylinder had been washed into the sea, but they were picked up. The other parts of the tide-gauge, including the clock, remained standing and are uninjured. With the ready help received from the Port Blair Public Works Department, the tidal observatory, which had to be partly renewed and thoroughly repaired, was set up as before against the sea-wall adjoining the Port Officer's house, which is on the west side of Ross Island. The eastern side of the framework of the observatory is secured to the sea-wall, while the western is supported on two stout piles, driven well into the ground. The observatory is built entirely of wood, and is 12½ feet by 10 feet inside measurement, and 10 feet high at the eaves: there is a door-way facing east and a large window on the west side. The float cylinder is of ¼ inch wrought iron, 14 feet long and 3 feet internal diameter: it is in two lengths of 7 feet each, bolted together. The upper flange of the cylinder rests on the observatory floor, while the bottom rests on a circular stone 3 feet 2 inches in diameter. There are three inlet holes, ½ inch in diameter, 9 inches above the bottom, and three more of the same size 1 foot 6 inches above the bottom. The space included between the supporting piles and the sea wall has been strongly planked in, leaving about an inch waterway between the planks, thus affording protection to the cylinder, and also regulating the flow of water in and out of the barrier so made.

The tide-gauge set up in this observatory is of the old pattern by Adie, modified by Légé and Co., and before modification it had been at work at Aden. Its registrations at Port Blair commenced on the 30th January.

The anemometer, which had been in the Poona Office, and which is of the old pattern by Adie, started work on January 25th at the site occupied by the old instrument on the top of the European Barracks. The aneroid, which had also been in the Poona Office, and is of the old pattern by Adie, started work on February 10th in the tidal observatory.

The mercurial barometer, which had been formerly in use at Elephant Point, was set up in the tidal observatory, and its readings were taken from the date on which tidal observations were resumed.

The time kept in the observatory is checked by comparing the observatory chronometer with the chronometers on the Mail Steamers: but to make more certain of correct mean time being kept, a sun-dial of Colonel Strahan's pattern has been made by the Mathematical Instrument Office, which can be set up at the next inspection of the observatory.

A graduated staff, the zero of which agrees with that of the tide-gauge, has been set up against the pile at the north-west corner of the observatory, to check the height of the water inside the cylinder with that outside.

The rain-gauge, after being repaired, was set up again on its original stand near the flag-staff at the European Barracks. After making a full inspection of the observatory, I left Port Blair on the 17th of February for Rangoon, taking with me the mercurial barometer, which had escaped damage, to be utilised at Diamond Island after comparison with a standard. The disabled instruments, namely, the tide-gauge, and remains of the aneroid and anemometer, were sent to Poona."

From the foregoing it will be seen that between the 21st September 1891 (the diagrams in the observatory at the time of the cyclone going back to that date) and the 30th January 1892, when tidal observations were resumed, there are no original tidal records, but as the hourly tidal readings entered in the daily reports are forthcoming up to October 29th, the break in the observations is practically reduced to one of 3 months. Since the re-establishment of the observatory the tide-gauge has worked very satisfactorily. The only accidental suspension of its records took place one night in February, when the pencil failed to mark the diagram for the short period of 8 hours. The aneroid has worked continuously; but its record is unsatisfactory from the 5th April, since which date the barometric diurnal variation has not been correctly indicated: the readings of the mercurial barometer taken daily at 7 A. M., 10 A. M., 4 P. M., and 6 P. M. give, however, the required information. The anemometer, which, as Mr. Belcham reports, started work on January 25th, is the instrument that was damaged by a rifle shot on the 17th December 1890 at Port Blair, as mentioned in my last Annual Report. It worked well for only about six weeks after its re-establishment. The clerk reported that on March 15th he found a toothed wheel in the upper part of the machine, connected with the velocity spiral, worn out; and he had a spare one, left by Mr. Belcham, substituted for it by a local mechanic on March 17th. From this date the instrument worked very imperfectly until April 20th, and then ceased to work at all. It has been sent for again and will be repaired in my office, if possible, and another anemometer will be taken to Port Blair, and set up at the next inspection. Our thanks are due to the Meteorological Department who have been kindly helping us to keep our auxiliary data complete by furnishing the clerk with the daily velocity and general direction of the wind as registered at their own observatory. We are also greatly indebted to Colonel Cadell, V.C., the Chief Commissioner of the Andamans, and his Public Works and Port staff for their prompt and energetic help, especially at a time when they must have had many other urgent calls upon their attention.

The records of the movements of the wind at Port Blair, as indeed at other places, are not as free from uncertainty as could be wished. Comparisons of the wind velocity at Port Blair, as recorded by our instrument (an anemograph) and the Meteorological Department's dial instrument, showed great discrepancies. Between the 3rd and 11th February 1892,

for example, while the wind was blowing from the north-east, our instrument recorded a velocity varying from 1½ to more than 3 times the velocity registered by the other. When this was noticed, a comparison of the record of the two instruments between the 6th and 14th June 1891, while the wind was blowing from the south-west, was made, and showed that the dial instrument then gave the greater readings, though only slightly the greater. With regard to the respective positions of the two instruments, Mr. Belcham reported:—"Our anemometer was at work on the top of the European barracks, which is situated on the ridge at the north-east extremity of Ross Island, while the instrument belonging to the Meteorological Department was on the Station Hospital on the south-west end of the ridge, but not on quite as elevated a position, and about 500 yards from the barracks. Our anemometer catches the full force of the wind from the north-east, but not from the south-west, as the Chief Commissioner's house, which is on the highest point, cuts it off to some extent; the Meteorological Department's instrument, on the other hand, catches fully the wind from the south-west and not so much of that from the north-east." Very close agreement between the readings of the two instruments could not, perhaps, be expected under such conditions; but discrepancies so wide suggest that, even if the instruments had been under exactly the same influences, they would not have read accordantly. Anemometers do not seem to me to be very satisfactory instruments. They appear to be generally accepted on faith, just as they are received from the maker, and I know of no certain means available to me of testing the accuracy of their registration of wind velocity. In the pattern we use there is a considerable amount of friction between the parts, and the toothed wheels and spirals, consequently, are continually wearing out and have to be renewed. Even assuming such an instrument to have been a true recorder of wind-velocity originally, there is no certainty that it continues so, after such repairs.

I have already given two instances of the corrosive influence of the sea water on the tide-gauge apparatus. This influence is remarkable at five of the tidal stations, namely, Bombay, Galle, Amherst, Mergui, and Port Blair; but it is not noticeable at the other stations. At Bombay, owing to the corrosive action of the sea, the copper float had to be renewed in 1886, the new float had to be repaired twice in 1887, and the counterpoise chain broke in 1892. At Galle, owing to the same cause, the iron cylinder had to be repaired twice and renewed once in six years, and the copper float band had to be renewed twice, and the counterpoise chain three times in the same period. At Amherst, similarly, holes were eaten through the cylinder, and the copper band broke three times in six years. At Mergui, since the commencement of tidal observations there in 1889, the corrosive action of the sea has rendered necessary the renewal of the copper float band once, and the repair of the counterpoise chain seven times. At Port Blair, during the eleven years from 1880 to 1891, three iron cylinders and three copper float bands were used up in a similar way, and the fourth cylinder and band were destroyed in the cyclone of November 1st.

How the sea acts so detrimentally on iron and copper at these exceptional stations, or whether, or how far, its action may be assisted by marine animals, I do not know.

The loss of three months' observations at Port Blair is a matter of great regret. If this heavy loss be excepted, I think I am entitled to report that the tidal operations of the year have been very successful.

Reduction of the Tidal Observations and Extra Tidal Work.

The observations for one year at 14 tidal stations have been reduced, and the tabulated values of the tidal constants so obtained are appended.

I again take the opportunity to remark that it was mentioned in the General Report for 1887-88 that a commencement had been made tentatively towards utilising the meteorological records of the tidal observatories for tidal purposes, three years' observations at Kárwár having been selected for treatment, and Mr. Roberts of the Nautical Almanac Office was requested to run off, by means of the tide predicting machine at the India Office, certain constituent tides required in the investigation. Nothing, however, has as yet been heard from him on the subject, and the investigation must be postponed until we receive the curves applied for.

The present state of the ordinary tidal computations is shown in the table following, together with their state at the end of September 1891. The letters A. P. in the table indicate that the actual times and heights of high and low water have been measured from the tidal diagrams or graduated staves and compared with their predicted values published in the tide tables. The actual amount of the usual work done during the year under report can thus be seen at a glance.

The extra tidal work is not entered in the table. This consisted in furnishing the Marine Survey of India with the value of the datum for Minicoy and the establishment of the port; in settling, in consultation with the officer in charge of that survey, the final datum lines for several Indian ports, to be adopted both in the Marine charts and in the tide tables: in supplying the Officer Commanding the Royal Artillery in the Rangoon District with the height of mean tide level at Rangoon above the River Surveyor's datum for the eleven years 1880-1891: in miscellaneous work and correspondence connected with the preparation of the Tidal volume: and in submitting reports, as before, on the tidal operations carried on in the Bombay Presidency and in Burma, to the Local Governments.

State of the ordinary reductions of the yearly tidal registrations at the beginning and end of the Survey year 1891-92.

Tidal Observatory.	State at end of September 1891.	State at end of September 1892.
ADEN	1889-90., calculations completed. 1890-91, observations rejected in part. A. P. 1890.	1891-92, calculations completed. A. P. 1891.
KURRACHEE	1889-90, calculations completed. 1890-91, calculations completed. A. P. 1890.	1891-92, calculations completed. A. P. 1891.
BHAVNAGAR	1890, calculations completed. A. P. 1890.	1891, calculations completed. A. P. 1891.
BOMBAY (Apollo Bandar).	1890, calculations completed. A. P. 1890.	1891, calculations completed. A P. 1891.
BOMBAY (Prince's Dock).	1890, calculations completed. A. P. 1890.	1891, calculations completed. A. P. 1891.
COCHIN (closed 20th March 1892).	1890-91, calculations completed. A. P. 1890.	1891, calculations completed. A. P. 1891.
MINICOY (started 12th January 1891).	Newly started observatory.	1891, calculations completed.
COLOMBO (closed 29th March 1890).	A. P. 1890.	*Nil.*
GALLE (closed 11th April 1890).	A. P. 1890.	*Nil.*
TRINCOMALEE (started 10th November 1890).	Newly started observatory.	1891-92, calculations completed.
TUTICORIN	1890-91, calculations completed. A. P. 1890.	1891-92, calculations completed. A. P. 1891.
MADRAS (closed 10th October 1890).	1889-90, calculations completed. A. P. 1890.	*Nil.*
COCANADA (closed 18th April 1891).	1890-91, calculations completed. A. P. 1890.	A. P. 1891.
KIDDERPORE	1889-90, calculations completed. 1890-91, calculations completed.	1891-92, calculations completed. A. P. 1891.
CHITTAGONG (closed 22nd July 1891).	1890-91, calculations completed. A. P. 1890.	A. P. 1891.
AKYAB (closed 23rd May 1892).	1890-91, calculations completed. A. P. 1890.	1891-92, calculations completed. A. P. 1891.
RANGOON	1889-90, calculations completed. 1890-91, calculations completed.	1891-92, calculations completed. A. P. 1891.
MOULMEIN	A. P. 1890.	A. P. 1891.
MERGUI	1890-91, calculations completed.	1891-92, calculations completed. A. P. 1891.
PORT BLAIR	1890-91, calculations completed. A. P. 1890.	1890-91, new calculations ending October 29, 1891, necessitated by cyclone.

Particulars of the completed tidal diagrams sent for safe custody to the Surveyor-General's Office Calcutta, are given in the following table: —

Tidal Observatory.	Serial number and date of Tidal Diagram.
ADEN	No. 1, dated March 3, 1879, to No. 296, dated March 22, 1886.
KURRACHEE	No. 1, dated December 26, 1880, to No. 225, dated February 14, 1887.
BOMBAY (Apollo Bandar)	No. 1 A., dated December 26, 1877, to No. 292, dated January 16, 1890.
MORMUGÃO	No. 1 R., dated March 12, 1884, to No. 54, dated January 1, 1886.* No. 91, dated January 4, 1887, to No. 106, dated March 27, 1889.
KÁRWÁR	Complete series from No. 1, dated February 18, 1878, to No. 270, dated April 16, 1883.
BEYPORE	Complete series from No. 1, dated November 1, 1878, to No. 330, dated March 14, 1885.
COCHIN	No. 1, dated January 25, 1886, to No. 137, dated December 30, 1889.
TUTICORIN	No. 1, dated May 30, 1888, to No. 71, dated October 7, 1889.
GALLE	Complete series from No. 1, dated March 23, 1884, to No. 143, dated December 15, 1886 † No. 148, dated January 17, 1887, to No. 316, dated April 11, 1890.
COLOMBO	Complete series from No. 1 A., dated January 25, 1884, to No. 328, dated March 29, 1890.
PAUMBEN	Complete series from No. 1, dated September 25, 1878, to No. 222, dated December 27, 1882.
NEGAPATAM	Complete series from No. 1, dated November 1, 1881, to No. 325, dated April 9, 1888.
MADRAS	Complete series from No. 1 R., dated February 2, 1879, to No. 23 R., dated July 14, 1879; and from No. 2, dated January 26, 1880, to No. 395, dated October 10, 5890.‡
COCANADA	Complete series from No. 1, dated March 31, 1886, to No. 132, dated April 18, 1891.
VIZAGAPATAM	No. 1 R., dated August 3, 1878, to No 18 R., dated December 7, 1878.
DIAMOND HARBOUR	No. 48, dated March 31, 1884, to No. 123, dated April 11, 1886.§
CHITTAGONG	No. 1, dated June 6, 1886, to No. 108 dated June 23, 1890.
AKYAB	No. 1, dated May 9, 1887, to No. 97, dated December 15, 1890.
ELEPHANT POINT (new site.)	No. 1, dated December 29, 1883, to No. 50, dated January 19, 1885.
MERGUI	No 1, dated March 21, 1889, to No. 20, dated December 23, 1889.

* No. 55 to 90 kept for the present in Poona.
† No. 144 to 147 being blank were not sent.
‡There are no diagrams for the interval July 14, 1879, to January 26, 1880.
§The other diagrams are kept for the present in Poona.

VALUES OF THE TIDAL CONSTANTS, ADEN, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

A_0=5·845 feet.

S_1	H=R=	·101	M_6	R=	·002	Q_1	R=	·171	T_2	R=	...
	κ=ζ=	169°·91		ζ=	243°·44		ζ=	30°·19		ζ=	...
S_2	H=R=	·656		H=	·002		H=	·155		H=	...
	κ=ζ=	244°·36		κ=	33°·44		κ=	43°·56		κ=	...
S_4	H=R=	·006	M_8	R=	·001	L_2	R=	·037	$(MS)_4$	R=	·016
	κ=ζ=	245°·56		ζ=	284°·04		ζ=	271°·39		ζ=	9°·83
S_6	H=R=	·005		H=	·001		H=	·059		H=	·016
	κ=ζ=	193°·17		κ=	244°·04		κ=	193°·27		κ=	179°·83
S_8	H=R=	·000	O_1	R=	·723	N_2	R=	·404	$(2SM)_2$	R=	·023
	κ=ζ=	161°·57		ζ=	107°·35		ζ=	328°·64		ζ=	266°·77
				H=	·652		H=	·411		H=	·024
				κ=	36°·61		κ=	218°·76		κ=	96°·77
M_1	R=	·108	K_1	R=	1·396	λ_2	R=	...	$2N_2$	R=	·073
	ζ=	48°·09		ζ=	150°·15		ζ=	...		ζ=	224°·05
	H=	·050		H=	1·309		H=	...		H=	·074
	κ=	36°·20		κ=	33°·88		κ=	...		κ=	194°·28
M_2	R=	1·547	K_2	R=	·223	υ_2	R=	·060	$(M_2N)_4$	R=	·024
	ζ=	55°·79		ζ=	288°·35		ζ=	20°·14		ζ=	34°·47
	H=	1·576		H=	·192		H=	·061		H=	·024
	κ=	225°·79		κ=	235°·26		κ=	281°·89		κ=	94°·59
M_3	R=	·016	P_1	R=	·373	μ_2	R=	·078	$(M_2K_1)_3$	R=	·034
	ζ=	307°·52		ζ=	281°·05		ζ=	216°·24		ζ=	286°·38
	H=	·017		H=	·373		H=	·080		H=	·032
	κ=	202°·52		κ=	30°·20		κ=	196°·24		κ=	340°·12
M_4	R=	·004	J_1	R=	·149	R_2	R=	...	$(2M_2K_1)_3$	R=	·009
	ζ=	340°·25		ζ=	240°·84		ζ=	...		ζ=	241°·89
	H=	·005		H=	·135		H=	...		H=	·008
	κ=	320°·25		κ=	41°·48		κ=	...		κ=	338°·15

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·029	86°·48	·031	6°·36
„ Fortnightly „	·059	220·07	·047	351·57
Luni-Solar „ „	·014	105·77	·014	295·77
Solar-Annual „	·346	11·46	·346	352·31
„ Semi-Annual „	·141	135·37	·141	97·08

VALUES OF THE TIDAL CONSTANTS, KURRACHEE, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Kurrachee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

A_0=7·114 feet.

S_1	H=R=	·093	M_6	R=	·047	Q_1	R=	·148	T_2	R=	·108
	κ=ζ=	164·11		ζ=	42°·04		ζ=	143°·56		ζ=	105°·63
S_2*	H=R=	·945		H=	·050		H=	·132		H=	·108
	κ=ζ=	323°·90		κ=	201°·15		κ=	47°·42		κ=	347°·76
S_4	H=R=	·009	M_8	R=	·008	L_2	R=	·081	$(MS)_4$	R=	041
	κ=ζ=	27°·93		ζ=	290°·77		ζ=	298°·76		ζ=	152°·91
S_6	H=R=	·008		H=	·008		H=	·141		H=	·042
	κ=ζ=	287°·99		κ=	262°·92		κ=	268°·23		κ=	325°·95

Short Period Tides—contd.

A_0=7·114 feet.

S_8	H = R =	·001	O_1	R =	·731	N_2	R =	·581	$(2SM)_2$	R =	·014
	κ = ζ =	82°·88		ζ =	172°·53		ζ =	76°·40		ζ =	287°·07
				H =	·655		H =	·593		H =	·014
				κ =	46°·32		κ =	279°·51		κ =	114°·04
M_1	R =	·118	K_1	R =	1·411	λ_2	R =	...	$2N_2$	R =	·089
	ζ =	32°·99		ζ =	103°·63		ζ =	...		ζ =	10° 82
	H =	·053		H =	1·317		H =	...		H =	·091
	κ =	26°·18		κ =	45°·74		κ =	...		κ =	244°·01
M_2	R =	2·563	K_2	R =	·331	ν_2	R =	·095	$(M_2N)_4$	R =	·066
	ζ =	120°·61		ζ =	255°·95		ζ =	267°·68		ζ =	61°·57
	H =	2·615		H =	·281		H =	·097		H =	·069
	κ =	293°·64		κ =	319°·58		κ =	225°·47		κ =	77°·72
M_3	R =	·027	P_1	R =	·373	μ_2	R =	·072	$(M_2K_1)_3$	R =	·055
	ζ =	72°·62		ζ =	356°·53		ζ =	287°·14		ζ =	338°·28
	H =	·027		H =	·373		H =	·075		H =	·053
	κ =	332°·17		κ =	47° 58		κ =	273°·21		κ =	93°·42
M_4	R =	·033	J_1	R =	·132	R_2	R =	...	$(2M_2K_1)_3$	R =	·028
	ζ =	1°·46		ζ =	154°·48		ζ =	...		ζ =	339°·89
	H =	·034		H =	·119		H =	...		H =	·027
	κ =	347°·53		κ =	63°·66		κ =	...		κ =	23°·86

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·054	16°·95	·058	346°·87
„ Fortnightly „	·005	188·05	·004	73·51
Luni-Solar „ „	·044	234·84	·045	61·80
Solar-Annual „	·070	2·11	·070	41·05
„ Semi-Annual „	·086	47·37	·086	125·25

Values of the Tidal Constants, Bhávnagar, 1891.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891 observations at Bhávnagar; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891 observations:—

Short Period Tides.

A_0=22·592 feet.

S_1	H = R =	·165	M_6	R =	·234	Q_1	R =	·213	T_2	R =	·370
	κ = ζ =	195°·69		ζ =	197°·12		ζ =	255°·85		ζ =	236°·98
S_2	H = R =	3·499		H =	·246		H =	·194		H =	·370
	κ = ζ =	176°·72		κ =	134°·28		κ =	92°·83		κ =	237°·40
S_4	H = R =	·125	M_3	R =	·015	L_2	R =	·579	$(MS)_4$	R =	·672
	κ = ζ =	238° 87		ζ =	65°·94		ζ =	247°·28		ζ =	337°·73
S_6	H = R =	·018		H =	·016		H =	·819		H =	·684
	κ = ζ =	291°·10		κ =	222°·16		κ =	144°·05		κ =	196°·79
S_8	H = R =	·002	O_1	R =	1°·77	N_2	R =	2·468	$2SM)_2$	R =	·091
	κ = ζ =	255°·07		ζ =	45° 21		ζ =	95°·68		ζ =	223°·97
				H =	·980		H =	2·510		H =	·993
				κ =	84°·11		κ =	112°·80		κ =	4°·91
M_1	R =	·184	K_1	R =	2·512	λ_2	R =	...	$2N_2$	R =	·100
	ζ =	117°·22		ζ =	266°·92		ζ =	...		ζ =	291°·27
	H =	·088		H =	2·366		H =	...		H =	·101
	κ =	126°·02		κ =	90°·19		κ =	...		κ =	106°·46
M_2	R =	10·869	K_2	R =	1·629	ν_2	R =	·841	$(M_2N)_4$	R =	·355
	ζ =	274°·89		ζ =	351°·09		ζ =	192°·43		ζ =	240°·82
	H =	11·050		H =	·896		H =	·855		H =	·367
	κ =	133°·94		κ =	177° 07		κ =	114°·39		κ =	116°·99

Short Period Tides—contd.

A_0=22·592 feet.

M_3	R =	·081	P_1	R =	·681	μ_2	R =	·235	$(M_2K_1)_3$	R =	·329
	ζ =	300°·62		ζ =	288°·58		ζ =	191°·73		ζ =	64°·84
	H =	·083		H =	681		H =	·243		H =	·315
	κ =	269° 20		κ =	97°·93		κ =	269°·84		κ =	107°·17
M_4	R =	·880	J_1	R =	·182	R_2	R =	...	$2(M_2K_1)_3$	R =	·146
	ζ =	72°·94		ζ =	108° 58		ζ =	...		ζ =	100°·44
	H =	·919		H =	·166		H =	...		H =	·142
	κ =	151°·05		κ =	123°·66		κ =	...		κ =	355°·28

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·095	180°·85	·101	22°·78
„ Fortnightly „	·096	73·92	·078	35·16
Luni-Solar „ „	·173	281·02	·176	61·97
Solar-Annual „	·268	212·21	·268	132·86
„ Semi-Annual „	·033	170·33	·033	11·63

Values of the Tidal Constants, Bombay (Apollo Bandar), 1891.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891 observations at Bombay (Apollo Bandar); and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891 observations:—

Short Period Tides.

A_0=10·156 feet.

S_1	H = R =	·073	M_6	R =	·006	Q_1	R =	·154	T_2	R =	·152
	κ = ζ =	201°·63		ζ =	172°·48		ζ =	221° 86		ζ =	48°·77
S_2	H = R =	1·567		H =	·006		H =	·140		H =	·152
	κ = ζ =	5°·56		κ =	109°·78		κ =	58°·90		κ =	49°·19
S_4	H = R =	·016	M_8	R =	·002	L_2	R =	·101	$(MS)_4$	R =	·152
	κ = ζ =	220°·53		ζ =	183°·81		ζ =	19°·27		ζ =	183° 47
S_6	H = R =	·003		H =	·002		H =	·143		H =	·155
	κ = ζ =	184°·09		κ =	340°·22		κ =	276°·07		κ =	42°·58
S_8	H = P =	·001	O_1	R =	725	N_2	R =	·977	$(2SM)_2$	R =	·045
	κ = ζ =	221°·63		ζ =	8°·27		ζ =	297°·86		ζ =	350°·92
				H =	·660		H =	·993		H =	·046
				κ =	47°·22		κ =	315°·06		κ =	131°·82
M_1	R =	·118	K_1	R =	1·490	λ_2	R =	...	$2N_2$	R =	·138
	ζ =	65° 68		ζ =	222°·42		ζ =	...		ζ =	111°·82
	H =	056		H =	1·403		H =	...		H =	·140
	κ =	74°·50		κ =	45°·69		κ =	...		κ =	287°·10
M_2	R =	3·971	K_2	R =	·469	ν_2	R =	·267	$(M_2N)_4$	R =	·150
	ζ =	112° 46		ζ =	175°·03		ζ =	44°·91		ζ =	63°·38
	H =	4·037		H =	·408		H =	·271		H =	·155
	κ =	331°·56		κ =	1°·00		κ =	326°·94		κ =	299°·68
M_3	R =	·057	P_1	R =	·411	μ_2	R =	·243	$(M_2K_1)_3$	R =	·032
	ζ =	47°·50		ζ =	236°·47		ζ =	222°·96		ζ =	145°·33
	H =	·058		H =	·411		H =	·252		H =	·030
	κ =	16°·16		κ =	45°·81		κ =	301°·17		κ =	187°·70
M_4	R =	·135	J_1	R =	·129	R_2	R =	...	$(_2M_2K_1)_3$	R =	·077
	ζ =	262° 19		ζ =	22°·53		ζ =	...		ζ =	194°·97
	H =	·139		H =	·118		H =	...		H =	·075
	κ =	340°·39		κ =	44°·59		κ =	...		κ =	89°·90

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·040	154°·56	·042	356°·47
„ Fortnightly „	·061	80 65	·050	41·84
Luni-Solar „ „	·047	310·98	·048	91·87
Solar-Annual „	·057	31·09	·057	311·74
„ Semi-Annual „	·062	35·41	·062	236·71

VALUES OF THE TIDAL CONSTANTS, BOMBAY (PRINCE'S DOCK), 1891.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891 observations at Bombay (Prince's Dock) ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891 observations :—

Short Period Tides.

$A_0 = 8{\cdot}187$ feet.

S_1	H =	·083	M_6	R =	·014	Q_1	R =	·159	T_2	R =	·153
	κ =	198°·89		ζ =	233°·22		ζ =	221°·34		ζ =	46°·51
S_2	H =	1·605		H =	·015		H =	·145		H =	·153
	κ =	3°·80		κ =	170°·53		κ =	58°·39		κ =	46°·93
S_4	H =	·027	M_8	R =	·003	L_2	R =	·130	$(MS)_4$	R =	·137
	κ =	220°44		ζ =	289°·18		ζ =	15°·03		ζ =	183°·69
S_6	H =	·004		H =	·003		H =	·184		H =	·139
	κ =	204°·44		κ =	85°·59		κ =	271°·83		κ =	42°·79
S_8	H =	·001	O_1	R =	·714	N_2	R =	·985	$(2SM)_2$	R =	·046
	κ =	172°·88		ζ =	6°·90		ζ =	296°·99		ζ =	339°·53
				H =	·649		H =	1·001		H =	·047
				κ =	45°·86		κ =	314°·18		κ =	120°·43
M_1	R =	·120	K_1	R =	1·482	λ_2	R =	...	$2N_2$	R =	·144
	ζ =	65°·13		ζ =	221°·01		ζ =	...		ζ =	112°·23
	H =	·057		H =	1·395		H =	...		H =	·147
	κ =	73°·95		κ =	44°·28		κ =	...		κ =	287°·51
M_2	R =	4·039	K_2	R =	·463	υ_2	R =	·267	$(M_2N)_4$	R =	·147
	ζ =	110°·12		ζ =	173°·66		ζ =	44°·16		ζ =	63°·80
	H =	4·106		H =	·403		H =	·272		H =	·152
	κ =	329°·22		κ =	359°·64		κ =	326°·19		κ =	300°·10
M_3	R =	·065	P_1	R =	·403	μ_2	R =	·242	$(M_2K_1)_3$	R =	·028
	ζ =	43°·86		ζ =	234°·71		ζ =	225°·10		ζ =	170°·03
	H =	·067		H =	·403		H =	·250		H =	·027
	κ =	12°·51		κ =	44°·05		κ =	303°·31		κ =	212° 40
M_4	R =	·109	J_1	R =	·125	R_2	R =	...	$(2M_2K_1)_3$	R =	0·70
	ζ =	251°·39		ζ =	24°·51		ζ =	...		ζ =	186°·87
	H =	·113		H =	·114		H =	...		H =	·069
	κ =	329°·60		κ =	46°·56		κ =	...		κ =	81°·80

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·051	159°·19	·054	1°·10
„ Fortnightly „	·070	75·33	·057	36·52
Luni-Solar „ „	·051	284·50	·062	65·40
Solar-Annual „	·105	33·40	·105	314·06
„ Semi-Annual „	·065	1·83	·065	203·13

Values of the Tidal Constants, Cochin, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Cochin; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

$A_0 = 2{\cdot}331$ feet.

S_1	H =		M_6	R =	·008	Q_1	R =	·069	T_2	R =	·028
	κ =	ζ = 189°·26		ζ =	115°·84		ζ =	85°·20		ζ =	26°·38
S_2	H =	R = ·265		H =	·008		H =	·063		H =	·028
	κ =	ζ = 30°·71		κ =	98°·45		κ =	80°·11		κ =	3°·16
S_4	H =	R = ·005	M_8	R =	·006	L_2	R =	·021	$(MS)_4$	R =	·021
	κ =	ζ = 192°·76		ζ =	355°·60		ζ =	15°·18		ζ =	151°·89
S_6	H =	R = ·007		H =	·007		H =	·031		H =	·021
	κ =	ζ = 228°·01		κ =	332°·41		κ =	359°·25		κ =	146°·10
S_8	H =	R = ·001	O_1	R =	·338	N_2	R =	·143	$(2SM)_2$	R =	·002
	κ =	ζ = 284°·04		ζ =	269°·20		ζ =	103°·22		ζ =	304°·70
				H =	·306		H =	·145		H =	·002
				κ =	59°·46		κ =	302°·08		κ =	310°·49
M_1	R =	·036	K_1	R =	·629	λ_2	R =	...	$2N_2$	R =	·013
	ζ =	353°·45		ζ =	205°·14		ζ =	...		ζ =	231°·77
	H =	·017		H =	·591		H =	...		H =	·013
	κ =	71°·36		κ =	52°·16		κ =	...		κ =	275°·28
M_2	R =	·715	K_2	R =	·100	υ_2	R =	·047	$(M_2N)_4$	R =	·021
	ζ =	338°·59		ζ =	149°·79		ζ =	198°·87		ζ =	268°·83
	H =	·727		H =	·086		H =	·048		H =	·021
	κ =	332°·79		κ =	23°·26		κ =	344°·51		κ =	101°·89
M_3	R =	·015	P_1	R =	·168	μ_2	R =	·003	$(M_2K_1)_3$	R =	·026
	ζ =	34°·96		ζ =	263°·99		ζ =	113°·43		ζ =	302°·57
	H =	·016		H =	·168		H =	·003		H =	·025
	κ =	206°·26		κ =	49°·70		κ =	101°·83		κ =	143°·79
M_4	R =	·028	J_1	R =	·037	R_2	R =	...	$(2M_2K_1)_3$	R =	·020
	ζ =	95°·58		ζ =	44°·56		ζ =	...		ζ =	325°·43
	H =	·029		H =	0·34		H =	...		H =	·020
	κ =	83°·99		κ =	43°·85		κ =	...		κ =	106°·82

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·029	159°·70	·031	315°·04
„ Fortnighly „	·088	133·26	·071	6·95
Luni-Solar „ „	·024	311·43	·024	317·23
Solar-Annual „	·295	8·66	·295	312·95
„ Semi-Annual „	·273	200·86	·073	29·46

Values of the Tidal Constants, Minicoy, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Minicoy; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

$A_0 = 5{\cdot}174$ feet.

S_1	H =	R = ·037	M_6	R =	·004	Q_1	R =	·082	T_2	R =	...
	κ =	ζ = 209°·86		ζ =	253°·01		ζ =	288°·97		ζ =	...
S_2	H =	R = ·360		H =	.004		H =	·075		H =	...
	κ =	ζ = 18°·83		κ =	105°·81		κ =	63°·23		κ =	...

Short Period Tides—contd.

$A_0 = 5{\cdot}174$ feet.

S_4	H =	·003	M_8	R =	·002	L^1	R =	·014	$(MS)_4$	R =	·005
	R =			ζ =	335°·23		ζ =	246°·70		ζ =	176°·42
	κ =	128°·05		H =	·002		H =	·021		H =	·005
	ζ =			κ =	138°·95		κ =	18°·49		κ =	127°·36
S_6	H =	·001	O_1	R =	·373	N_2	R =	·177	(2SM)	R =	·002
	R =			ζ =	298°·61		ζ =	335°·35		ζ =	256°·76
	κ =	170°·54		H =	·338		H =	·180		H =	·002
	ζ =			κ =	58°·49		κ =	300°·67		κ =	305°·83
S_8	H =	·000	K	R =	·738	λ_2	R =	...	$2N_2$	R =	·023
	R =			ζ =	215°·61		ζ =	...		ζ =	266°·49
	κ =	213°·69		H =	·695		H =	...		H =	·024
	ζ =			κ =	49°·76		κ =	...		κ =	246°·19
M_1	R =	·067	K_2	R =	·110	ν_2	R =	·057	$(M_2N)_4$	R =	·015
	ζ =	150°·12		ζ =	163°·40		ζ =	67°·37		ζ =	307°·27
	H =	·032		H =	·096		H =	·058		H =	·015
	κ =	25°·56		κ =	11°·14		κ =	316°·76		κ =	223°·52
M_2	R =	·865	P_1	R =	·224	μ_2	R =	·005	$(M_2K_1)_3$	R =	·009
	ζ =	16°·85		ζ =	248°·84		ζ =	16°·93		ζ =	260°·43
	H =	·880		H =	·224		H =	·005		H =	·008
	κ =	327°·78		κ =	47°·35		κ =	278°·79		κ =	45°·51
M_3	R =	·007	J_1	R =	·071	R_2	R =	...	$(2M_2K_1)_3$	R =	·002
	ζ =	248°·96		ζ =	259°·41		ζ =	...		ζ =	140°·19
	H =	·007		H =	·065		H =	...		H =	·002
	κ =	175°·36		κ =	76°·08		κ =	...		κ =	207°·90
M_4	R =	·010									
	ζ =	116°·04									
	H =	·011									
	κ =	17°·91									

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	039	82°·69	·032	68°·31
„ Fortnightly „	·078	119·68	·063	10·86
Luni-Solar „ „	·011	6·49	·011	55·56
Solar-Annual „	·369	63·70	·369	355·19
„ Semi-Annual „	·106	50·93	·106	273·92

Values of the Tidal Constants, Tuticorin, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Tuticorin; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

$A_0 = 2{\cdot}074$ feet.

S_1	H =	·040	M_6	R =	·015	Q_1	R =	·031	T_2	R =	·025
	R =			ζ =	41°·92		ζ =	322°·84		ζ =	280°·24
	κ =	51°·16		H =	·016		H =	·028		H =	·025
	ζ =			κ =	22°·79		κ =	77°·88		κ =	130°·87
S_2	H =	·473	M_8	R =	·012	L_2	R =	·024	$(MS)_4$	R =	·013
	R =			ζ =	197°·86		ζ =	59°·08		ζ =	145°·42
	κ =	83°·10		H =	·013		H =	·042		H =	·013
	ζ =			κ =	292°·36		κ =	23°·20		κ =	259°·05
S_4	H =	·006	O_1	R =	·124	N_2	R =	·082	$(2SM)_2$	R =	·006
	R =			ζ =	264°·81		ζ =	309°·08		ζ =	58°·27
	κ =	238°·86		H =	·111		H =	·084		H =	·009
	ζ =			κ =	47°·45		κ =	35°·11		κ =	304°·64
S_6	H =	·004	K_1	R =	·331	λ_2	R =	...	$2N_2$	R =	·010
	R =			ζ =	53°·27		ζ =	...		ζ =	37°·22
	κ =	145°·22		H =	·308		H =	...		H =	·010
	ζ =			κ =	27°·04		κ =	...		κ =	95°·65
S_8	H =	·007									
	R =										
	κ =	222°·17									
	ζ =										
M_1	R =	·009									
	ζ =	29°·50									
	H =	·004									
	κ =	354°·88									

Short Period Tides—contd.

A_0=2·074 feet.

M_2	R =	·653	K_2	R =	·152	ν_2	R =	0·24	$(M_2N)_4$	R =	·022
	ζ =	289°·09		ζ =	318°·61		ζ =	106°·89		ζ =	242°·32
	H =	·667		H =	·128		H =	·024		H =	·023
	κ =	42°·71		κ =	85°·57		κ =	3° 50		κ =	81°·97
M_3	R =	·019	P_1	R =	·075	μ_2	R =	·027	$(M_2K_1)_3$	R =	·005
	ζ =	349°·86		ζ =	353°·58		ζ =	224°·23		ζ =	305°·27
	H =	·019		H =	·075		H =	·028		H =	·005
	κ =	160°·30		κ =	13°·13		κ =	91°·48		κ =	32°·67
M_4	R =	·025	J_1	R =	·025	R_2	R =	...	$(\frac{1}{2}M_2K_1)_3$	R =	·005
	ζ =	285° 09		ζ =	65°·01		ζ =	...		ζ =	339°·44
	H =	·026		H =	·022		H =	...		H =	·005
	κ =	152°·33		κ =	63°·59		κ =	...		κ =	232°·92

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·047	192°·33	·051	219°·93
,, Fortnightly ,, ...	·080	351·49	·063	359·84
Luni-Solar ,, ,, ...	·045	29·72	·046	276·09
Solar-Annual ,, ...	·241	245·71	·241	316·17
,, Semi-Annual ,, ...	·152	274·71	·152	55·62

Values of the Tidal Constants, Trincomalee, 1890-91.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1890-91 observations at Trincomalee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1890-91 observations:—

Short Period Tides.

A_0 = 1·842 feet.

S_1	H = R =	·018	M_6	R =	·006	Q_1	R =	·012	T_2	R =	..
	κ = ζ =	65°·25		ζ =	326°·31		ζ =	140°·57		ζ =	...
S_2	H = R =	·191		H =	·006		H =	·011		H =	...
	κ = ζ =	269° 31		κ =	108°·74		κ =	177°·27		κ =	...
S_4	H = R =	·007	M_8	R =	·002	L_2	R =	·041	$(MS)_4$	R =	·009
	κ = ζ =	251°·57		ζ =	329°·74		ζ =	181°·55		ζ =	142°·24
S_6	H = R =	·000		H =	·002		H =	·053		H =	.010
	κ = ζ =	45°·00		κ =	159°·61		κ =	308°·76		κ =	189°·70
S_8	H = R =	·001	O_1	R =	·068	N_2	R =	·142	$(2SM)_2$	R =	·010
	κ = ζ =	323°·13		ζ =	28°·66		ζ =	62°·56		ζ =	295°·54
				H =	·062		H =	·144		H =	·010
				κ =	307°·58		κ =	227°·80		κ =	248°·07
M_1	R =	·016	K_1	R =	·223	λ_2	R =	...	$2N_2$	R =	·024
	ζ =	85°·38		ζ =	199°·08		ζ =	...		ζ =	308°·58
	H =	·008		H =	·211		H =	...		H =	0·24
	κ =	4°·92		κ =	330°·86		κ =	...		κ =	231°·60
M_2	R =	·579	K_2	R =	·081	ν_2	R =	·047	$(M_2N)_4$	R =	·007
	ζ =	192°·68		ζ =	166°·28		ζ =	229°·76		ζ =	109°·59
	H =	·587		H =	·072		H =	·048		H =	·007
	κ =	240°·15		κ =	249° 29		κ =	208°·88		κ =	322°·30
M_3	R =	·004	P_1	R =	·074	μ_2	R =	·032	$(M_2K_1)_3$	R =	·008
	ζ =	122°·83		ζ =	122°·64		ζ =	65° 20		ζ =	18°·44
	H =	·004		H =	·074		H =	·033		H =	·008
	κ =	194° 03		κ =	343°·26		κ =	160°·13		κ =	197°·68
M_4	R =	·012	J_1	R =	·022	R_2	R =	...	$(\frac{1}{2}M_2K_1)_3$	R =	·005
	ζ =	129°·74		ζ =	268°·44		ζ =	...		ζ =	58°·47
	H =	·013		H =	·020		H =	...		H =	·005
	κ =	224°·67		κ =	279°·21		κ =	...		κ =	21°·62

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·022	88°·50	·023	330°·72
„ Fortnightly „	·067	334·91	·055	14·54
Luni-Solar „ „	·015	283·21	·015	235·75
Solar-Annual „	·291	52·03	·291	281·40
„ Semi-Annual „	·207	34·94	·207	133 69

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Kidderpore ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from 1891-92 observations :—

Short Period Tides.

A_0=10·618 feet.

S_1	H=R =	·086	M_6	R =	·145	Q_1	R =	·025	T_2	R =	·093
	κ = ζ =	198°·63		ζ =	114°·80		ζ =	353°·02		ζ =	258°·13
S_2	H=R =	1·541		H =	·154		H =	·022		H =	·093
	κ = ζ =	99°·47		κ =	323°·91		κ =	356°·69		κ =	179°·74
S_4	H=R =	·108	M_8	R =	·059	L_2	R =	·171	$(MS)_4$	R =	·692
	κ = ζ =	105°·95		ζ =	355°·29		ζ =	31°·00		ζ =	8°·93
S_6	H=R =	·003		H =	·064		H =	·279		H =	·706
	κ = ζ =	65°·86		κ =	274°·10		κ =	97°·67		κ =	78°·63
S_8	H=R =	·002	O_1	R =	·232	N_2	R =	·626	$(2SM)_4$	R =	·084
	κ = ζ =	246°·04		ζ =	211°·33		ζ =	140°·67		ζ =	85°·32
				H =	·209		H =	·638		H =	·086
				κ =	21°·55		κ =	43°·83		κ =	15°·61
M_1	R =	·023	K_1	R =	·409	λ_2	R =	...	$2N_2$	R =	·040
	ζ =	22°·41		ζ =	151°·10		ζ =	...		ζ =	316°·85
	H =	·011		H =	383		H =	...		H =	·041
	κ =	141°·53		κ =	53°·53		κ =	...		κ =	53°·46
M_2	R =	3·576	K_2	R =	·586	ν_2	R =	·131	(M_2N_4)	R =	·115
	ζ =	347° 22		ζ =	110°·22		ζ =	56°·88		ζ =	289°·35
	H =	3·645		H =	502		H =	·133		H =	·119
	κ =	56°·92		κ =	94°·51		κ =	4°·68		κ =	262°·21
M_3	R =	·015	P_1	R =	·151	μ_2	R =	·265	$(M_2K_1)_3$	R =	·146
	ζ =	39°·02		ζ =	310°·06		ζ =	49°·79		ζ =	66°·27
	H =	·016		H =	·151		H =	·275		H =	·139
	κ =	323°·58		κ =	40°·60		κ =	189°·20		κ =	38°·41
M_4	R =	·727	J_1	R =	·25	R_2	R =	...	$(2M^2K_1)_3$	R =	·040
	ζ =	257°·04		ζ =	282°·86		ζ =	...		ζ =	98°·66
	H =	7·55		H =	·022		H =	...		H =	·038
	κ =	36°·45		κ =	348°·89		κ =	...		κ =	335°·63

Long Period Tides.

	R	ζ		κ
Lunar Monthly Tide	0·301	202°·65	0·323	9°·20
„ Fortnightly „	0·257	117·96	0·205	27·23
Luni-Solar „ „	0·883	113·64	0·900	43·94
Solar-Annual „	2·527	153·23	2·527	152·69
„ Semi-Annual „	0·751	341·33	0·751	340·25

Values of the Tidal Constants, Akyab, 1891-92.

The flloowing are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Akyab; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

$A_0 = 7'452$ feet.

S_1	H =	·050	M_6	R =	·024	Q_1	R =	·013	T_2	R =	·062
	κ = ζ =	74°·69		ζ =	187°·60		ζ =	320°·14		ζ =	356°·28
S_2	H = R =	1·142		H =	·025		H =	·012		H =	·062
	κ = ζ =	306°·90		κ =	126°·87		κ =	279°·28		κ =	230°·60
S_4	H = R =	·005	M_8	R =	010	L_2	R =	·068	$(MS)_4$	R =	·015
	κ = ζ =	178°·78		ζ =	227°·05		ζ =	62°·98		ζ =	327°·56
S_6	H = R =	·003		H =	·010		H =	·119		H =	·015
	κ = ζ =	103°·50		κ =	146°·08		κ =	301°·87		κ =	307°·32
S_8	H = R =	·002	O_1	R =	·203	N_2	R =	·498	$(2SM)_2$	R =	·036
	κ = ζ =	59°·93		ζ =	301°·88		ζ =	6°·31		ζ =	180°·81
				H =	·182		H =	·508		H =	·036
				κ =	334°·52		κ =	272°·57		κ =	201°·05
M_1	R =	·006	K_1	R =	·480	λ_2	R =	...	$2N_2$	R =	051
	ζ =	40°·18		ζ =	33°·01		ζ =	...		ζ =	83°·09
	H =	·003		H =	·448		H =	...		H =	·052
	κ =	297°·20		κ =	342°·97		κ =	...		κ =	275°·85
M_2	R =	2·509	K_2	R =	·364	ν_2	R =	·118	$(M_2N)_4$	R =	·108
	ζ =	297°·57		ζ =	225°·97		ζ =	192°·28		ζ =	241°·40
	H =	2·561		H =	·308		H =	·120		H =	·113
	κ =	277°·33		κ =	305°·31		κ =	227°·09		κ =	127°·42
M_3	R =	·013	P_1	R =	·136	μ_2	R =	·018	$(M_2K_1)_3$	R =	·013
	ζ =	69°·82		ζ =	302°·92		ζ =	295°·99		ζ =	316°·58
	H =	·013		H =	·136		H =	·019		H =	·013
	κ =	39°·46		κ =	346°·16		κ =	255°·51		κ =	246°·30
M_4	R =	·014	J_1	R =	·009	R_2	R =	...	$(2M_2K_1)_3$	R =	·019
	ζ =	335°·52		ζ =	298°·47		ζ =	...		ζ =	42°·61
	H =	·015		H =	·009		H =	...		H =	·019
	κ =	295°·04		κ =	319°·08		κ =	...		κ =	52°·16

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·075	304°·87	·081	18°·37
„ Fortnightly „	·052	165·07	·041	259·55
Luni-Solar „ „	·062	61·28	·063	81·53
Solar-Annual „	·883	84·43	·883	131·19
„ Semi-Annual „	·187	78·91	·187	172·43

Values of the Tidal Constants, Rangoon, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

$A_0 = 10'215$ feet.

S_1	H = R =	·114	M_6	R =	·231	Q_1	R =	·032	T_2	R =	·324
	κ = ζ =	126°·04		ζ =	133°·05		ζ =	324°·42		ζ =	234°·01
S_2	H = R =	2·209		H =	·244		H =	·029		H =	·324
	κ = ζ =	170°·22		κ =	79°·73		κ =	56°·13		κ =	176°·35
S_4	H = R =	·091	M_8	R =	·092	L_2	R =	·416	$(MS)_4$	R =	·376
	κ = ζ =	264°·44		ζ =	276°·32		ζ =	214°·90		ζ =	350°·43
S_6	H = R =	·014		H =	·099		H =	·657		H =	·383
	κ = ζ =	42°·11		κ =	85°·23		κ =	161°·19		κ =	212°·65

Short Period Tides—contd.

A_0=10·215 feet.

S_8	H=	·006	O_1	R=	·308	N_2	R=	1·041	$(2SM)_2$	R=	·200
	R=			ζ=	38°·12		ζ=	146°·18		ζ=	270°·17
	κ=	93°·07		H=	·278		H=	1·061		H=	·204
	ζ=			κ=	21°·72		κ=	116°·51		κ=	47°·95
M_1	R=	·028	K_1	R=	·748	λ_2	R=	...	$2N_2$	R=	·089
	ζ=	98°·28		ζ=	152°·93		ζ=	...		ζ=	106°·28
	H=	·013		H=	·701		H=	...		H=	·091
	κ=	112°·37		κ=	34°·55		κ=	...		κ=	184°·71
M_2	R=	5·971	K_2	R=	·717	ν_2	R=	·216	$(M_2N)_4$	R=	·166
	ζ=	268°·00		ζ=	225°·64		ζ=	170°·79		ζ=	236°·46
	H=	6·081		H=	·617		H=	·220		H=	·172
	κ=	130°·23		κ=	168°·30		κ=	149°·01		κ=	69°·02
M_3	R=	·028	P_1	R=	·163	μ_2	R=	·517	$(M_2K_1)_3$	R=	·104
	ζ=	207°·68		ζ=	307°·74		ζ=	201°·40		ζ=	5°·11
	H=	·029		H=	·162		H=	·537		H=	·099
	κ=	181°·02		κ=	59°·00		κ=	285°·85		κ=	108°·95
M_4	R=	·398	J_1	R=	·009	R_2	R=	...	$(_3M_2K_1)_3$	R=	·138
	ζ=	83°·81		ζ=	213°·69		ζ=	...		ζ=	209°·00
	H=	·413		H=	·009		H=	...		H=	·135
	κ=	168°·27		κ=	344°·21		κ=	...		κ=	51°·83

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·189	131°·80	0·202	23°·70
„ Fortnightly „	0·181	307·07	0·145	22·09
Luni-Solar „ „	0·446	269 52	0·454	47·29
Solar-Annual „	1·131	155·54	1·131	134·28
„ Semi-Annual „	0·141	310·18	0·141	267·66

Values of the Tidal Constants, Mergui, 1891-92.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1891-92 observations at Mergui; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891-92 observations:—

Short Period Tides.

A_0=12·902 feet.

S_1	H=	·065	M_6	R=	·076	Q_1	R=	·028	T_2	R=	·163
	R=			ζ=	312°·35		ζ=	238°·33		ζ=	93°·88
	κ=	69°·92		H=	·081		H=	·025		H=	·163
	ζ=			κ=	236°·69		κ=	281°·53		κ=	16°·51
S_2	H=	2·946	M_8	R=	·012	L_2	R=	·209	$(MS)_4$	R=	·158
	R=			ζ=	26°·57		ζ=	227°·64		ζ=	83°·22
	κ=	347°·90		H=	·013		H=	·340		H=	·161
	ζ=			κ=	45°·69		κ=	306°·04		κ=	178°·00
S_4	R=	·050	O_1	R=	·233	N_2	R=	1·000	$(2SM)_2$	R=	·154
	R=			ζ=	116°·40		ζ=	6°·01		ζ=	218°·95
	κ=	236°·47		H=	·210		H=	1·019		H=	·157
	ζ=			κ=	312°·72		κ=	307°·68		κ=	124°·17
S_6	H=	·017	K_1	R=	·557	λ_2	R=	...	$2N_2$	R=	·161
	R=			ζ=	73°·29		ζ=	...		ζ=	164°·17
	κ=	92°·39		H=	·521		H=	...		H=	·164
	ζ=			κ=	334°·70		κ=	...		κ=	312°·73
S_8	H=	·002	K_2	R=	1·028	ν_2	R=	·050	$(M_2N)_4$	R=	·136
	R=			ζ=	1°·57		ζ=	256°·36		ζ=	206°·41
	κ=	148°·00		H=	·880		H=	·051		H=	·141
	ζ=			κ=	343°·82		κ=	240°·88		κ=	242°·86
M_1	R=	·009									
	ζ=	244°·27									
	H=	·004									
	κ=	15°·86									
M_2	R=	5·402									
	ζ=	213°·60									
	H=	5·505									
	κ=	308°·38									

Short Period Tides—contd.

A_0=12·902 feet.

M_3	R =	·063	P_1	R =	·151	μ_2	R =	·409	$(M_2K_1)_3$	R =	·039
	ζ =	172°·74		ζ =	240°·25		ζ =	160°·09		ζ =	305°·38
	H =	·064		H =	·151		H =	·425		H =	·037
	κ =	134°·91		κ =	331°·81		κ =	349°·65		κ =	301°·57
M_4	R =	·128	J_1	R =	·026	R_2	R =	...	$(2M_2K_1)_3$	R =	·006
	ζ =	302°·55		ζ =	238°·39		ζ =	...		ζ =	299°·25
	H =	·112		H =	·024		H =	...		H =	·006
	κ =	132°·11		κ =	289°·96		κ =	...		κ =	227°·39

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·078	234°·38	·084	27°·49
„ Fortnightly „ . . .	·054	155·12	·043	37·27
Luni-Solar „ „ . . .	·042	143·77	·043	48·99
Solar-Annual „ . . .	·528	142·47	·528	140·92
„ Semi-Annual „ . . .	·125	161·35	·125	158·25

VALUES OF THE CONSTANTS, PORT BLAIR, 1890-91.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1890-91 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1890-91 observations, commencing 24th October 1890:—

Short Period Tides.

A_0=4·606 feet.

S_1	H = R =	·013	M_6	R =	·006	Q_1	R =	·025	T_2	R =	...
	κ = ζ =	51°·34		ζ =	222°·83		ζ =	261°·11		ζ =	...
S_2	H = R =	·974		H =	·007		H =	·023		H =	...
	κ = ζ =	312°·00		κ =	170°·98		κ =	232°·47		κ =	...
S_4	H = R =	·001	M_8	R =	·003	L_2	R =	·082	$(MS)_4$	R =	·011
	κ = ζ =	331°·39		ζ =	269°·00		ζ =	316°·83		ζ =	187°·13
S_6	H = R =	·001		H =	·003		H =	·102		H =	·011
	κ = ζ =	233°·13		κ =	319°·88		κ =	271°·09		κ =	289°·84
S_8	H = R =	·002	O_1	R =	·171	N_2	R =	·409	$(2SM)_2$	R =	·027
	κ = ζ =	43°·15		ζ =	308°·15		ζ =	192°·72		ζ =	237°·88
				H =	·157		H =	·415		H =	·027
				κ =	299°·21		κ =	275°·74		κ =	135°·16
M_1	R =	·013	K_1	R =	·419	γ_2	R =	...	$2N_2$	R =	·051
	ζ =	122°·71		ζ =	211°·68		ζ =	...		ζ =	204°·15
	H =	·007		H =	·397		H =	...		H =	·052
	κ =	248°·67		κ =	326°·60		κ =	...		κ =	267°·46
M_2	R =	1·992	K_2	R =	·335	ν_2	R =	·086	$(M_2N)_4$	R =	·040
	ζ =	174°·32		ζ =	262°·27		ζ =	356°·78		ζ =	105°·41
	H =	2·021		H =	·296		H =	·088		H =	·041
	κ =	277°·04		κ =	311°·59		κ =	223°·89		κ =	291°·15
M_3	R =	·007	P_1	R =	·122	μ_2	R =	·091	$(M_2K_1)_3$	R =	·026
	ζ =	66°·70		ζ =	90°·33		ζ =	85°·56		ζ =	134°·84
	H =	·008		H =	·122		H =	·094		H =	·025
	κ =	40°·77		κ =	327°·74		κ =	290°·99		κ =	352°·48
M_4	R =	·006	J_1	R =	·025	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	260°·22		ζ =	176°·96		ζ =	...		ζ =	140°·96
	H =	·006		H =	·023		H =	...		H =	·005
	κ =	105°·65		κ =	308°·32		κ =	...		κ =	231°·48

	R	ζ	H	κ
Lunar Monthly Tide . . .	·036	269°·92	·038	289°·62
„ Fortnightly „ . . .	·064	57·63	·053	358·23
Luni-Solar „ „ . . .	·013	214·30	·013	111·59
Solar-Annual „ . . .	·241	278·33	·241	130·92
„ Semi-Annual „ . . .	·136	98·54	·136	163·71

The Tide Tables.

In addition to the calculations already mentioned, the usual work has been done in connection with the issue of the Tide Tables for 1892 (which arrived at my office from London in three instalments, namely, on November 11th, and December 15th, 1891, and January 11th 1892, and were at once distributed), and with the preparation of those for 1893. In connection with the latter the values of the constants, which were calculated in the usual manner, were sent to Mr. Roberts ready for use in the Tide Predictor; and in addition he was furnished with the actual values during 1891 of every high and low water at 14 stations measured in duplicate from the tidal diagrams, together with tidal observations for the same year taken daily during daylight from a graduated staff at the site of the Moulmein tidal observatory, and similar observations for some months of that year taken at the sites of the Chittagong and Cocanada observatories, kindly supplied with great regularity by the Port Officers.

In order to save Mr. Roberts the labour of the calculations, all the predicted times and heights of high and low water for 1891 at these stations were compared with the above mentioned actual values and the errors tabulated, thus giving him in a convenient form information likely to assist him in improving the predictions. I do not know how far he utilises this information. I have already drawn attention to the excess during the last six years, of the predicted heights of low water over the actual heights, during the month of August, at Moulmein. The principal riverain stations are Kidderpore, Rangoon, and Moulmein, and the tidal observations taken at them are reduced by a special method in separate monthly groups, each group extending from the first to the last year of the observations, there being a January group, a February group and so on, as explained in the preface to the Hooghly River Tide Tables for 1888.

The values obtained from these groups are understood to be modified by Mr. Roberts where necessary by the light of the tables of differences between the actual and predicted high and low water values which are sent to him yearly with that object. In the Tide Tables for 1891, which is the latest volume that can be examined as a whole, the height predictions at Kidderpore were too high at both high and low water during the first half of August, and the last half of October. At Rangoon they were too high at low water in August, September, October and November. At Moulmein they were too high in August and September. For the anticipated height of the tide to be too great especially at low water is not only inconvenient, but may be dangerous; and it is to be hoped that as Mr. Roberts accumulates data he may be able to increase the accuracy of the riverain predictions; though I am afraid we can never hope for extreme accuracy at riverain stations, where the height of the water may be unexpectedly influenced by exceptional seasons, bringing with them an excess or scarcity of rain or snow.

At page xiv of the appendix to the General Report for 1889-90, there is a table of "comparisons between datum as adopted for the tide tables and that adopted for chart soundings." When that table was prepared, an effort that began several years previously was still being made to introduce "Indian spring low-water mark," the scientific datum, at as many tidal stations as possible.

At each station where this had been done, the preface to the tide tables contained a statement that in calculating the heights they were referred to the scientific datum; the difference between this and the datum for chart soundings (unless it happened to be the scientific datum) was given, and if small, it was added that the two might be accepted as practically identical, and at the foot of the tables of high and low water a note was put for the guidance of navigators, stating that the heights were referrible to the datum for chart soundings. This plan, which has had a sufficiently long trial, is not satisfactory; and after consulting qualified persons who largely use the tide tables, I had adopted the datum of sounding in the latest charts as the datum for the Tide Tables for 1893, stating in each preface the difference (where it exists) between this and the scientific datum to enable scientific people to refer the heights to the latter if they feel so inclined. The table of comparisons contained in the General Report for 1889-90 has thus become obsolete, and in place of it I give the following table. A description of the datum of each tidal station entered

in it, including the level of the datum with reference to a well-known bench mark, will be found in the preface for the station in the tide tables.

Tidal Station.	Datum of soundings in latest Charts and for Tide Tables, 1893.
Aden	Low-water equinoctial springs.
Kurrachee	Mean low-water of ordinary spring-tides.
Okha	Approximate mean of lowest ordinary spring-tides.
Port Albert Victor	Low-water of ordinary spring-tides.
Bhávnagar	The level of lowest low-water springs observed by Marine Survey in 1886.
Bombáy—*	
Apollo Bandar	Mean of the lowest ordinary spring-tides.
Mormugáo	Mean low-water of ordinary spring-tides.
Kárwár	Ditto ditto ditto.
Beypore	Lowest low-water spring-tides.
Cochin	Mean low-water of ordinary spring-tides.
Minicoy	8·05 feet below a bench-mark near the *Kacheri*.
Tuticorin	Mean low water of ordinary spring-tides.
Colombo	Ditto ditto ditto.
Galle	Ditto ditto ditto.
Trincomalee	Ditto ditto ditto.
Pámban	Ditto ditto ditto.
Negapatam	10·73 feet below a bench-mark in Marine Office.
Madras	Indian spring low-water mark.
Cocanada	Ditto ditto.
Vizagapatam	Ditto ditto.
False Point	Lowest low-water during the dry season.
Dublat	The zero of Kedgeree gauge.
Diamond Harbour	Mean low-water of ordinary springs at Kidderpore.
Calcutta—	
Kidderpore	Ditto ditto ditto ditto.
Chittagong	Low-water spring-tides of the dry season.
Akyab	Mean low-water of ordinary spring-tides.
Elephant Point	Low-water of spring-tides of the dry season.
Rangoon	Ditto ditto ditto.
Amherst	Low-water ordinary spring-tides.
Moulmein	21·34 feet below a bench-mark in the Port Office.
Mergui	Indian spring low-water mark.
Port Blair	Ditto ditto.

* Bombay, Prince's Dock:—The datum is Prince's Dock sill: this is 14·00 feet lower than the Apollo Bandar datum.

The volumes of Tide Tables for 1893 will contain predictions for 33 tidal stations, the new stations of Trincomalee and Minicoy having been added since the last issue.

The amount realised by the sale of the Tide Tables is much the same as it was last year, and the limited number of presentation copies are distributed in strict accordance with the lists sanctioned by Government.

The usual tabular statements are appended, showing the percentage and amount of the errors in the predicted times and heights of high and low water for the year 1891 at 15 stations, as determined by comparison of the predictions entered in the Tide Tables for that year with the values obtained by actual measurement.

No. 1.

Statement showing the percentage and the amount of the Errors in the Predicted Times of High Water at the various Tidal Stations for the year 1891.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	677	35	43	13	7	2
Kurrachee	703	18	37	20	20	5
Bhávnagar	688	21	36	13	18	12
Bombay { Apollo Bandar	705	28	48	12	10	2
Bombay { Prince's Dock	700	41	44	8	6	1
Cochin	697	22	35	15	19	9
Tuticorin	686	40	39	8	9	4
Cocanada	463	49	45	4	2	...
Kidderpore	690	26	36	12	18	8
Chittagong	553	30	39	9	15	7
Akyab	704	40	46	8	5	1
Rangoon	679	23	39	12	19	7
Moulmein	361	38	40	8	8	6
Mergui	697	36	45	8	7	4
Port Blair	507	45	44	6	5	...

No. 2.

Statement showing the percentage and the amount of the Errors in the Predicted Times of Low Water at the various Tidal Stations for the year 1891.

Stations.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	663	34	42	12	8	4
Kurrachee	702	29	38	14	14	5
Bhávnagar	691	20	28	11	21	20
Bombay { Apollo Bandar	705	30	43	10	12	5
Bombay { Prince's Dock	703	27	44	14	11	4
Cochin	695	38	44	9	6	3
Tuticorin	682	42	38	8	9	3
Cocanada	461	50	42	5	2	1
Kidderpore	686	23	35	14	17	11
Chittagong	551	26	26	12	19	17
Akyab	705	44	44	7	4	1
Rangoon	675	31	34	11	13	11
Moulmein	362	36	37	9	9	9
Mergui	702	24	37	14	15	10
Port Blair	504	42	45	7	5	1

No. 3.

Statement showing the percentage and the amount of the Errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1891.

Stations.	Number of comparisons between the actual and predicted values.	Mean range at springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per ce	Per cent.	Per cent.	Per cent.
Aden	677	6·7	92	8	...	...
Kurrachee	703	9·7	85	14	1	...
Bhávnagar	688	31·8	43	24	17	16
Bombay { Apollo Bandar	705	14·5	73	21	5	1
Bombay { Prince's Dock	700	14·6	55	33	10	2
Cochin	697	3·2	91	9	...	...
Tuticorin	686	3·2	88	12	...	...
Cocanada	463	5·2	70	25	5	...
Kidderpore	690	11·7	40	30	16	14
Chittagong	553	13·5	24	20	27	29
Akyab	794	8·4	77	21	2	...
Rangoon	679	16·4	53	30	12	5
Moulmein	361	12·7	43	24	17	16
Mergui	697	18·1	60	29	9	2
Port Blair	507	6·6	93	7	...	...

No. 4.

Statement showing the percentage and the amount of the Errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1891.

Stations.	Number of comparisons between the actual and predicted values.	Mean range at springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per cent.	Per cent.	Per cent.	Per cent.
Aden	663	6·7	94	6	...	...
Kurrachee	702	9·7	76	19	5	...
Bhávnagar	691	31·8	16	16	16	52
Bombay { Apollo Bandar	705	14·5	69	26	5	
Bombay { Prince's Dock	703	14·6	58	32	9	1
Cochin	695	3·2	89	11	...	...
Tuticorin	682	3·2	86	13	1	...
Cocanada	461	5·2	67	26	6	1
Kidderpore	686	11·7	47	30	14	9
Chittagong	551	13·5	45	30	14	11
Akyab	705	8·4	63	28	8	1
Rangoon	675	16·4	21	25	18	36
Moulmein	362	12·7	37	22	13	28
Mergui	702	18·1	43	24	19	14
Port Blair	504	6·6	93	7	...	...

No. 5.

Table of Average Errors in the Predicted Times and Heights of High and Low Water at the several Tidal Stations for the year 1891.

Stations.	Mean range at springs in feet.	Average Errors.					
		Of time in minutes.		Of height in terms of the range.		Of height in inches.	
		H. W.	L. W.	H W.	L. W.	H. W.	L. W.
Open Coast.							
Aden	6·7	10	11	·025	·025	2	2
Kurrachee	9·7	14	12	·026	·026	3	3
Bhávnagar	31·8	16	19	·018	·034	7	13
Bombay { Apollo Bandar	14·5	11	12	·017	·023	3	4
Bombay { Prince's Dock	14·6	9	12	·029	·023	5	4
Cochin	3·2	15	9	·052	·052	2	2
Tuticorin	3·2	10	10	·052	·052	2	2
Cocanada	5·2	7	7	·048	·048	3	3
Akyab	8·4	8	8	·030	·040	3	4
Mergui	18·1	10	15	·018	·028	4	6
Port Blair	6·6	8	8	·025	·025	2	2
General Mean		11	11	·031	·034		
Riverain.							
Kidderpore	11·7	14	15	·050	·043	7	6
Chittagong	13·5	13	17	·062	·043	10	7
Rangoon	16·4	14	13	·025	·056	5	11
Moulmein	12·7	11	12	·046	·066	7	10
General Mean		13	14	·046	·052		

The foregoing statements for the year 1891 may be summarised as follows:—

Percentage of Time predictions within 15 minutes of actuals.

	High water Per cent.	Low water Per cent.
11 Open coast stations	76	75
4 Riverain stations	68	62

Percentage of Height predictions within 8 inches of actuals.

	High water Per cent.	Low water Per cent.
11 Open coast stations	94	87
4 Riverain stations	66	64

Percentage of Height predictions agreeing with actuals within one-tenth of mean range at springs.

	High water Per cent.	Low water Per cent.
11 Open coast stations	97	96
4 Riverain stations	92	88

These figures are very satisfactory, and show a high standard of accuracy in the predictions taken as a whole. A comparison of the average errors of the past three years shows that the predictions for 1891 compare favourably with the exceptionally good predictions obtained in 1889.

Bench Marks.

During the year under report, 48 ordinary embedded bench marks, 425 inscribed or minor bench marks, 46 railway bench marks, 10 P. W. D. bench marks and 12 G. T. Survey stations were connected in the course of last season's levelling operations.

All the bench marks of reference at the tidal stations were found undisturbed and in good condition without exception.

The height of embedded test bench mark at Perambur No. $\frac{2}{12}$ of Spirit Levelled Heights No. 1, Madras Presidency, mentioned at pp. xxxvii and xxxviii of the appendix to last year's General Report, was re-determined by spirit-levelling, and found to be greater by 0·05 feet than it was originally. The description of the restored bench mark was given in my letter No. 103, dated 18th January 1892, and it differs materially from the original description.

LEVELLING OPERATIONS.

The spirit-levelling operations of the last field season consisted of a continuous line of double levelling, which may be divided, for convenience, into the following sections :—

(*a*) Section from Malkhed Railway station along the Nagpur line of the Great Indian Peninsula Railway to Nagpur Railway station.
(*b*) Section from Nagpur Railway station along the Bengal-Nagpur Railway to Bilaspur Railway station.
(*c*) Section from Bilaspur Railway station along the Bengal-Nagpur Railway to Sakti Railway station.

The out-turn amounts to 452 miles of double levelling in the course of which the instrument was set up at 3,387 stations and the heights of 529 permanent bench marks and 12 stations of the Great Trigonometrical Survey were determined. This is a good out-turn and creditable to Mr. Bond, who conducted the operations, especially when the unfortunate circumstances under which he was working, and which are mentioned in the following extract from his report to me on his season's work, are taken into consideration. For the assistance afforded to him and his detachment our thanks are due to the Engineers of the Great Indian Peninsula and Bengal-Nagpur Railways.

The loss the Department has sustained by the death of Sub-Surveyor Narsing Das is regretted not only by all members of this party, but I am sure by many other members of the Department who, during his long service, have had the opportunity of appreciating his many excellencies, not only as a native gentleman of high character but as an able and energetic worker whose devotion to duty, always conspicuous, could not have been better exemplified than in the closing act of his honourable career.

In the Department "Notes" for May 1892 the following paragraph appeared :—

"The Surveyor-General regrets to announce the death, on the 5th April last, at Bilaspur, of Narsing Das, Sub-Surveyor of the Tidal and Levelling Party. Narsing Das joined the Survey Department on 1st May 1864, and rendered valuable service for nearly 27 years, during the greater portion of which he was employed in levelling conjointly with Captain (now Lieutenant-Colonel) Baird, R.E, Lieutenant Trotter, R.E., Captain Carter, R.E., Messrs. Lane, Donnelly, Belcham, Neuville, Rendell, Cusson, and Bond. His zeal and intelligence have been highly commended by the officers under whom he has served, and at the time of his death the question of his promotion to the Junior Division, on the recommendation of his executive officer, Lieutenant-Colonel J. Hill, R.E., was under consideration."

Extract from Report by MR. J. BOND, *Extra Assistant Superintendent, 3rd grade, on the levelling operations executed by him.—Season 1891-92 :—*

The line of levels completed during the season may be divided into three sections :—

I. From Malkhed to Nagpur.—This section emanated from the embedded bench mark at Malkhed Railway station and was carried along the Nagpur line of the Great Indian Peninsula Railway to Nagpur, closing on an embedded bench mark at the Railway station. The length of this section, exclusive of 16 miles, of branch lines is 98 miles.

II. From Nagpur to Bilaspur.—This section started from the embedded bench mark at Nagpur Railway station, where the previous section closed, and was carried along the Bengal-Nagpur Railway *viâ* Raipur to Bilaspur, closing on the embedded bench mark at the Railway station. The length of this section, exclusive of 27 miles of branch lines, is 257 miles.

III. From Bilaspur to Sakti.—This section emanated from the embedded bench mark at the Railway station, and was carried along the Bengal-Nagpur Railway to Sakti, closing on the embedded bench mark at the Railway station. The length of this section, exclusive of 2 miles of branch lines, is 52 miles.

Branch lines were carried to all the large towns in the vicinity of the main line of levels, and several bench marks have been laid down at Amraoti, Nagpur, Kamptee, Raipur, and Bilaspur, all of which have been inscribed in the usual manner.

The levelling crossed three Principal Series of the Great Trigonometrical Survey, and connected the following stations, Badali H.S., Wirur H S, and Nachangaon H.S., of the Great Arc Series; Gorapur S, Khara H.S., and Sitapur H.S., of the Jabalpur Meridional Series; Lawa H S. common to both these series; and Raipur S., Bodri T.S., and Bilaspur S. of the Bilaspur Meridional Series.

Owing to the large differences of length of the hollow staves N_1, N_2 (determined the previous season from comparison with the 10-foot standard bar), you instructed me to make more frequent comparisons, and at Nagpur these staves were dispensed with and another solid pair, received from the Calcutta office, substituted. Comparisons were taken at the beginning and end of each of the above-mentioned sections, and it will be seen from the following table that the differences of length of both pairs from the 10-foot standard bar are much more accordant.

Results of comparison of staves.

Date of comparison.	Mean difference of length of pairs of staves from 10 feet.	
	Staves B and B^2.	Staves N and N^2.
At Amraoti, 31st October 1891	−·000380′	−·001443′
At Nagpur, 7th December 1891	−·001817′	−·005815′
		Staves B_3 and B_4.
At Nagpur, 13th December 1891	−·001545′	−·000453′
At Dongargarh, 14th February 1892	−·002088′	−·001208′
At Bilaspur, 8th April 1892	−·002490′	−·004118′
At Sakti, 30th April 1892	−·003578′	−·005246′

I append the usual tabular statement of the out-turn of levelling, also the following tables:—

Table A giving the Great Trigonometrical Survey Principal and Secondary Stations connected, and the errors of their heights as determined trigonometrically.

Table B, the Railway bench marks connected on the Bengal-Nagpur Line, with their errors.

Table C, the Public Works Department bench marks connected, and their errors.

The values of the bench marks connected on the Great Indian Peninsula Railway last season were not furnished by the company, and cannot therefore be compared with ours.

Tabular Statement of out-turn of work for the field season 1891-92, by the Levelling Detachment under Mr. J. Bond.

During the month of	Number of Miles Double Levelling.				Total Number of Feet.		Number of stations at which the instrument was set up.	Number of Bench marks embedded, inscribed and connected.				
	Main Line.		Branch Line.		Rises.	Falls.		Ordinary embedded.	Inscribed.	G. T. Survey Stations.	Railway.	Public Works Department.
	Ms.	Chs.	Ms.	Chs.	ft.	ft.						
November 1891 . .	74	46·54	15	3·30	1,693	1,042	784	8	95	3	6	...
December ,, . .	49	53·04	14	40·90	1,072	692	521	6	61	2	7	9
January 1892 . .	58	6·70	3	73·31	1,529	443	461	8	55	1	7	...
February ,, . .	100	73·00	2	77·91	1,158	1,001	683	12	90	1	11	...
March ,, . .	71	17·70	3	46·50	555	600	504	9	74	2	9	1
April ,, . .	52	28·06	5	29·46	426	539	434	5	50	3	6	...
Totals .	406	65·04	45	31·38	6,433	4,317	3,387	48	425	12	46	10
Total Number of Miles Double Levelling.			452	16	Total of rises and falls.	10,750						

Table A.

List of Great Trigonometrical Survey Principal and Secondary Stations connected by spirit-levelling, Season 1891-92:—

Series.	Name of station.	Height in feet above Mean Sea Level.		Error of height by Triangulation in feet.	Remarks.
		By spirit-levelling.	By Triangulation.		
Great Arc.	Badali H. S. . .	1563·9	1567·5*	+4	Top of closing pillar.
	Wírúr H. S. . .	1190·9	1196·5*	+6	Do.
	Náchangaon H. S. .	1234	1227	—7	Mark stone.
	Láwá H. S. .	1314	1311	—3	Do.
	Láwá H. S. .				
Jabalpur Meridional.	Gordpur S. . .	974	973	—1	Do.
	Khara H. S. . .	2005·9	2003·5*	—2	Top of closing pillar.
	Sítápár H. S. . .	1241·9	1240·5*	—1	Do.
Biláspur ditto	Raijpur S. . .	999	1000	+1	Mark on roof.
	Bodri T. S. . .	947	942	—5	Top of pillar.
	Biláspur S. . .	859	853	—6	Upper mark stone.
	Gathaura T. S. . .	907	901	—6	Ground floor mark.
	Kotgarh S. . .	1008	999	—9	Top of circular pillar.

* Includes height of closing pillar=3·5 feet.

Table B.

List of Railway Bench Marks on the Bengal-Nagpur Railway connected by the Survey of India Levelling Operations—Season 1891-92.

No.	Bench Marks.	Height above Mean sea level in feet. By Survey of India Levelling Operations.	By Railway Levels.	Error of Railway Levels in feet.
13	Rail at Kamptee Railway Station	938·75	935	−4
23	„ Salwa „	946·95	942	−5
35	„ Tharsa „	946·25	942	−4
44	„ Khat „	923·86	919	−5
81	„ Tirora „	908·38	905	−3
90	„ Gangejhari „	1,021·37	1,023	+2
102	„ Gondia „	1,021·07	1,017	−4
118	„ Amgaon „	1 020·00	1,016	−4
130	„ Salekasa „	1,052·51	1,049	−4
138	„ Darekasa „	1,238·19	1,234	−4
146	„ Bortalao „	1,320·41	1,316	−4
174	„ Nandgaon „	1,009·79	1,007	−3
184	„ Muripar „	1,026·07	1,022	−4
195	„ Drug „	964·83	962	−3
204	„ Bhilai „	998·59	995	−4
212	„ Kumhari „	935·60	931	−5
220	„ Raipur „	957·72	954	−4
229	„ Mandhar „	928·09	924	−4
237	„ Silyari „	910·34	906	−4
247	„ Tilda „	946·52	941	−6
255	„ Hathband „	921·50	918	−4
265	„ Bhatapara „	886·61	883	−4
277	„ Nipania „	847·89	844	−4
288	„ Belha „	876·56	872	−5
298	„ Bilaspur „	882·56	878 882·34	−4 −0
13	Rail at Paraghat Railway Station	873·14	870	−3
20	„ Akaltara „	919·73	917	−3
38	„ Champa „	851·95	848	−4
47	„ Baraduar „	839·31	835	−4
57	„ Sakti „	766·89	762	−5

Table C.

Comparisons of D. P. W. Bench Marks connected by Spirit levelling, Season 1891-92.

Number.	Bench Marks.	Heights above Mean sea-level in feet. By Survey of India Levelling Operations.	By D. P. W. Levels.	Error of D. P. W Levels in feet
3/1	G. T. S. B. M. At Nagpur, General Post Office	1,025·13	1,020·56	−4·57
5/1	G. T. S. B. M. At Nagpur, Obelisk near old Residency	1,019·79	1,015·27	−4·52
6/1	G. T. S. B. M. No. 48 At Nagpur, Museum	1,006·91	1,002·32	−4·59
7/1	G. T. S. B. M. No. 20 At Nagpur, Protestant Church	1,650·61	1,046·12	−4·49
8/1	G. T. S. B. M. No. 16. At Nagpur, District Court	1,019·39	1,014·92	−4·47

Comparisons of D. P. W. Bench Marks connected by Spirit levelling, Season 1891-92—contd.

Number.	Bench marks.	Heights above Mean sea-level in feet. By Survey of India Levelling Operations.	Heights above Mean sea-level in feet. By D P. W. Levels.	Error of D. P. W. Levels in feet.
$\frac{2}{14}$	G. T. S. B. ⩚ M. 1014·00. At Kamptee, Sadar Bazar	938·27	1,014·00	+57·73
$\frac{3}{14}$	G. T. S. B. ⩚ M. 990·06 At Kamptee, Vegetable Market	914·02	990·06	+76·04
$\frac{7}{14}$	G. T. S. ⩛ B. M. At Kamptee, Travellers' Bungalow . . .	923·37	...	...
$\frac{11}{222}$	$\frac{098\cdot76}{⩚}$ At Rajpur, well in Public Gardens	999·67	998·76	—0·91
	$\frac{870\cdot3}{⩚}$ At Bilaspur, Obelisk, 0·5 foot above Bench mark No. $\frac{3}{300}$.	872·2	870·3	—1·9

UPPER BURMA.

The Bret Country.

Notes on the part of the "Bret" Country, south-west of Karenni, visited in January 1892 by Captain H. M. Jackson, R.E., *in charge No. 11 Party.*

The portion of the Bret country to which these notes refer lies in the valley of the Tuchaung (*Karen*, Kanpreu or Preu-law) as far south as its eastern bend, towards its junction with the Nam Pawn (Ponchaung). The Brets extend a good deal south of this; but my other work did not allow of further explorations in this direction. A high well-defined range is the recognised boundary between the Bret country and Karenni.

The Brets are very much like other Karens in appearance, customs, habits, religion, dress, and dwellings. Their language is probably an old dialect that has remained unchanged owing to the isolation of the people in a somewhat inaccessible valley, through which there are only two trade routes, and those difficult and little used. The people on the eastern side of the valley have mixed a good deal with the Karenni, and their language has become slightly assimilated to that of their neighbours: those on the western side of the valley, however, speak a dialect which is apparently understood by the Karenni or by the Karens proper from the lower hills, or by the Padaung Karens from the north, or even by Brets from the eastern side of the valley. I had men of all these races with me, so I had good opportunity of judging. In one or two of the western villages, none of these could make themselves understood without great difficulty. I should imagine that the reason is this. The tribe or tribes of which the Brets are the remnant have been gradually driven westwards by the Karenni, to whom they are probably more akin than to the Karen Byu. Thus, those furthest west retain unaltered more of their original language, and this from fundamental difference or want of time has not yet been much affected by the language of the people they have now come into contact with. Possibly the western and eastern Brets may be remnants of different tribes who have come into the valley at different times, but there are no other differences apparent sufficient to support this idea.

In other respects the Brets apparently differ little from other Karens. The men all wear the cane garters peculiar to so many hill tribes from the Nagas southwards. Their burial places would denote a different origin from the Karenni: the latter invariably place a boat-shaped structure over the grave. The Brets place covered conical baskets containing provisions for the last journey: the men all carry spears,—heavy game spears, not the light javelins of the Karenni. There are a few Karenni cheek pieces (*bagas*) in each village and a very few very old muskets. From the scarcity of wild animals I should think that a good deal of hunting is carried on. The dogs, a small short-legged breed, are very clever at "driving" deer. Until lately, feuds between the different villages were apparently common; but the Bret is by no means the ferocious person he has been depicted. He is only a little wild, having comparatively recently passed from the hunting to the agricultural stage; and occasionally, as the country is difficult of cultivation, there being no open valleys, he gets tired of agriculture, or possibly hungry and goes on the

war path. Perhaps, only his neighbours suffer and retaliate, or perhaps, a Shan or Karen bullock caravan falls in his way and has to pay black mail, and so the Bret gets a bad name. It would take very little to keep these people in order. At present they have no real government or social system of any kind. There is generally a so-called head man in a big village; but he has not much authority as a rule. The American Baptist Mission has sent Burmese or Karen "teachers" into many of the Bret villages, and these men seem to have a good deal of influence.

The chief cultivation is rice, mostly in Taung-yas. Judging from the number of store-houses round each village a good deal is grown, but it is difficult to purchase even small quantities without giving notice, as they only husk enough for the daily consumption. Besides rice, maize (Hindi, *jawari;* Burmese, *pyaung-li gauk*) is grown, and a little cotton and tobacco; climbing peas (*pe-byu*) and pumpkins are plentiful. The tobacco is mostly worked by Karennis (from "Pobya") who bring their own elephants, as the Brets do not possess any of these animals. There is a good deal of teak in the valley of the Tu-chaung: I saw many small trees ringed, which would seem to show that the best have been cut; I certainly did not see any of any size.

Cotton is spun and woven into clothes in most of the villages. For iron working, the usual double bamboo bellows forge is used. In such a country, wood-cutting *dahs* and axes are the most important of a man's possessions. In one village, Kahbi, rough pots, etc., are made of a dark clay containing numerous particles of a yellow metallic substance, probably not gold, but I have not had an opportunity yet of having my specimens analysed.

Few domestic animals except pigs and fowls, of which there are plenty, are kept, except at one village, Kreuko, which possesses about 50 head of cattle. With the exception of one small grass *kwin* near Taiku, there is no open country in the valley: it is mostly heavy jungle, except where it has been cleared for cultivation.

The only bullock road through the part of the Bret country visited is that shown on the map; this had not been used for three years, on account of the practice of the villagers of Taiku, Kreuko, Kahbi, etc., of levying black mail and stealing stray bullocks. I had the Yadu branch opened up and improved; and I think that very likely it will become a small trade route in time, as Yadu is capable of any amount of development. The other means of communication are tracks which even the Burman pony cannot traverse. Those not in constant use are thickly overgrown with long grass and bamboos. Dr. Johnson of the American Baptist Mission has had several tracks cut from village to village of his parishioners in the western Bret. South of the part of the country I visited, a bullock trade route crosses from Bawgale in Toungoo to Bawlakhé in Karenni; by means of this I hope to complete the survey of the country next season.

I met with no opposition in going through the country, nor experienced unpleasantness of any kind. This was due in great part, I think, to my being accompanied by the *thugyi* of Yadu, who knows and is known by the northern Brets. I had twelve men of the Karen levy with me, but except to help in keeping together the coolies (these were Brets from Taiku, Padaung and Yadu, and quite the best coolies I have ever had south of the Himalayas), I think there was really little necessity for any escort at all. At only one village did the people run away on our approach; and they were soon persuaded to return by my *cicerone*, the Yadu *thugyi*. I could never quite discover whether this was a little exhibition got up for his own glorification by the latter gentleman, or whether, as he stated, the villagers of Kreuko had bad consciences; I am inclined to think the former, as he seemed so very pleased with himself about it.

HUKONG VALLEY.

Extract from a Report by MR. J. M. KENNEDY, *Sub-Assistant Superintendent, 1st grade, on his Survey Operations with the* MAINGKWAN COLUMN, *Season 1891-92.*

Having received orders to accompany the Maingkwan column, proceeding from Mogaung into the Hukong valley, I arrived at Bhamo, accompanied by Surveyor Faida Ali, on the 25th November 1891, and after spending a few days there in making the necessary arrangements, I left for Mogaung, *viâ* Sinbo, on the 30th, and was engaged during the march in triangulation. On the 8th December, while at Sinbo, when a halt was made to await the arrival of the last detachment of troops for the column, I sent back my police escort to Bhamo. The detachment arrived on the 12th and with it we left on the 15th for Mogaung, where, on the 19th, we joined the Europeans who had preceded us two or three days, and the whole force moved out next day to begin the work of the season

On the day previous I had, by turning off on the last march into Mogaung, observed at Umantaung hill station, a small steep hill a mile off the road at about 3 miles out of Mogaung. The hill top when I ascended it was so much overgrown with grass and brushwood, which could not be cleared for want of time, that the instrument had to be placed in a very unsteady position high up on one of the small pillars at the corners of the pagoda. This was the last station I was able to observe at, and, except when, later on, I left the column for short excursions around Maingkwan, I had no other opportunity of going 20 yards off the track of the column, where every man was assigned a definite place, which, moving or halting, he was obliged to keep.

From Mogaung the column moved by the road running north-west, 6 or 7 miles east of the Namkong Chaung between a small isolated block of hills and the larger mass of the Shwedaungyi ranges. On the second day's march the whole of the baggage and provision train failed to follow the route taken by the troops, who therefore camped out that night without proper food or shelter.

The column struck the Namkong again on the 23rd at a mile and a half above Kamaing and halted there a day: after three days' more marching, with another halt of four days at Hwélon to get up stores, we reached Laban on the 31st December. Another stay was made at Laban, during which observations for latitude were taken to check the route traverse. From Laban two raids were made on different days on the hill village of Nakum, supposed to be harbouring some murderers. I went out with the first party, traversing 18 miles of ground, to obtain 3 miles of new work. From Laban the sub-surveyor accompanying me had to be sent back, as he was declared by the medical officer with the column to be unfit for field work. Laban, which we were given to understand was a place of some importance, is a mere hamlet of two or three houses; and "old Laban," so marked on former maps, appears to have no existence. A site for a police stockade was cleared close by the village.

Leaving Laban on the 6th January the column marched to Sadusot, a tolerably large village; then by a long march reached the Tinkauk stream, passing over the watershed and out into the Hukong valley; another long march brought us to Palawbum, or Walawbum, called also Ponkaw, a large and thriving village on the west bank of the Nampyet. On the 9th, we marched to Maingkwan; the first three-quarters of the way by a good track, the remainder being, like all the paths immediately around Maingkwan, bad.

Maingkwan, or Meungkham, the golden city, an isolated Shan settlement, is said to have been (at sometime, doubtless rather remote) a town of 7,000 houses; it was, according to local report, a tolerably large place so late as 8 or 10 years ago, consisting then of some 150 houses; but, owing chiefly to the continuous raids of the surrounding hill tribes, it has since that time been reduced to an insignificant village of 27 houses. A dreary decayed appearance it now presents, no trace remaining of its former prosperity; the site even, of the old town, if such existed, being undiscoverable.

On the 10th and 11th January, I measured a base-line in the large fields about Maingkwan, and attempted some observations to fix the relative positions of the hills bounding the Hukong valley, but the weather was unfavourable throughout the stay of the column, and nothing very satisfactory in this way could be done. Latitude was observed and verified. On the 12th the amber mines on the small hills, four or five miles south, were visited. The average depth of the shafts is 10 or 12 feet, the deepest being 22 feet; these shafts are cut straight down and are about a foot and a half square—a convenient width to allow the digger to ascend and descend by planting his shoulders against one side of the shaft, and his feet in holes cut in the clay on the opposite side. Independent test-workings were executed by an officer of the Geological Survey, Dr. F. Noetling, who discovered nothing valuable here; this field had probably been long abandoned, and the larger and more profitable workings were afterwards reported to be further south on the same small range of hills near the village of Lalaung.

From Maingkwan, while the Political Officer was receiving deputations from the surrounding villages, I made independent excursions into the country round about, surveying up to the Tanaika river. The river at Mashi, where I first touched it, is about 150 yards wide, the south bank 20 feet high with deep water under, the opposite bank shelving with sands half way out into the bed of the river.

On the 14th January, the N. W. column, under Mr. Needham from Assam, arrived at Maingkwan. No surveyor accompanied this detachment, so that nothing but a line of route traverse had been done, and this on a very large scale. Of this work, for which I am indebted to Mr. Needham, a copy, reduced to the scale of the reconnaissance maps, will be made and submitted with my field sheets.

I accompanied a small detachment of the column on the 16th and 17th to Lalaung, a large village, a day's journey south of Maingkwan; here we were not welcomed with open arms, the head man appearing to be very ill-disposed towards us. We returned next day by a long circuitous march north-east along the Nampyu, falling into our old route at Pan and Sat, and so back to Maingkwan.

On the 20th, another detachment from the main column proceeded to examine the country to the north. Marching back along the Palawbum road to Naungku, we then turned northwards, camping the first day on the Tanaika or Chindwin at Salaw, thence to Makaw on the Tawan, a smaller river than the Tanaika; in two more marches we arrived at 'Ntup'nsa (observed latitude 26° 41'), the most northerly point the column reached. 'Ntup'nsa is a village of some importance, being the chief centre of the rubber trade in the valley, a trade which gives employment to a number of apparently wealthy Chinese whom we found here. We halted on the 24th and left next morning after a display of our small military force for the amusement (combined with instruction) of the chief of the village.

From 'Ntup'nsa, crossing and re-crossing the Nampraw Chaung, we marched to Kum and thence to Ningbyen, passing, at the junction of the Saksai and Taron rivers, the small stockaded village of Tabong, probably the "Dubong" of the old maps. At Ningbyen, which is a village of considerable size, there is a colony of Gurkhas, who have wandered

down here with the expectation of making a speedy fortune by collecting india-rubber; these pioneers of industry are now tied down, settlers per force, being indebted to the Kachins for advances of money and grain supplied them, which advances they are now unable to repay. The men and women are well fed and clad, however, and seem tolerably contented.

From Ningbyen, in company with the Political Officer, I made an excursion to Saraw, a stockaded village in a small rise overlooking a long reach of the Taron river, and giving a good view of the hills to the north. There is a long standing feud between this village and Palawbum, the Palawbum men having attacked and burned Saraw two years ago. We returned to Maingkwan, touching the Tawan river at Taraing, and crossing the Tanaika at Mashi; and, halting here a day or two, again started through Palawbum to 'Nbon, the most easterly village visited in the Hukong valley. The route from 'Ntup'nsa to 'Nbon having been surveyed by a military surveyor detached when we were at the former place, we turned westwards along the Tanaika, and, striking into one of the old routes at Salaw, returned to Maingkwan.

On the 13th February, the column left Maingkwan in two detachments; one accompanied by the military surveyor, Gunga Ram, returning by Laban to Fort O'Donnell, the other party which I accompanied starting in a north and north-westerly direction, following the course of the Chindwin into the Taro valley, which is separated by a single range of low hills from the Hukong valley. The marches between Kantao and Tagum were very trying, there being in most parts only the merest trace of a path, and on the river bank no track whatever. The soft clay bank covered with *kaing* grass, and broken with deep fissures, almost impassable for mules, made the progress of the column, even with the help of an advanced working party, very slow; the baggage at nightfall was here sometimes scattered along two or three miles, and the men who secured either bedding or food were fortunate.

Proceeding out of the Taro valley for three days after leaving Tagum we passed no villages, though small clearings were found in the hills. The troubles of the transport department ended here, for though the ascents and descents were steep, and fodder for the animals was not always procurable at night, we were now on a well-beaten track. At two or three days journey north of the Jade mines the country begins to be populated again, though the few villages passed through, with the exception of Pala, have a poverty-stricken air, occupants of these appearing to be chiefly old men and children; the able-bodied men are at this season at work at the Jade mines. No stay was made at the mines. An account of them has already been given by Captain P. J. Gordon in his report for 1890-91.

The important villages in the Hukong valley are 'Ntup'nsa, the centre of the rubber trade, Ningbyen with its Gurkha settlement, Saraw, Palawbum, and Lalaung on the hills, above which the larger amber mines are said to be. The chief products are india-rubber, jade, amber, ivory, and opium.

TIBET AND WESTERN CHINA.

Report by COLONEL T. H. HOLDICH, R.E., *in charge Simla Drawing Office, on the Route Survey executed by* ATMA RAM, *in company with* CAPTAIN BOWER, *in* TIBET AND WESTERN CHINA, *in 1891-92.*

INTRODUCTION.

Atma Ram, the author of the following notes on his journey from Changthang, eastwards to Ta-Chen-Lu on the confines of China, is a young man of about 24 years of age, who joined the Simla Drawing Office of the Survey of India Department on the 1st November 1890, as writer, and continued in that capacity until April of the following year when he volunteered to accompany Captain H. Bower, in trans-Himalayan explorations of little known regions.

This is what Captain Bower says of him:—

"I have the highest opinion of Atma Ram's powers of physical endurance in marching and camping out at high altitudes, and have nothing but praise for the excellent manner in which he conducted himself throughout the trying times he had in Tibet. He was as willing to lend a hand in loading our baggage animals, as he was untiring in keeping up the excellent record of the traverse survey. Nor was he less conspicuous in his willingness to shoulder a rifle, and I have no doubt that had it been necessary, he would not have flinched, at any critical moment, to have also used the weapon with good effect."

Atma Ram had been taught the use of the prismatic compass in the Forest Training School, at Dehra, where he had been a pupil for a short time; and though his knowledge of surveying was very slender and confined to the use of that one instrument, yet his natural quickness of adaptation and ability enabled him to employ that little knowledge with very good results. He has already shown himself to be a careful, steady and painstaking observer, and he will doubtless prove as resourceful a surveyor with the plane table, in any future explorations he may have the good fortune to undertake, as he is with the compass.

It may, perhaps, be due to the inhospitable region through which he traversed, on his journey in Tibet, that his narrative contains so few incidents of travel, or it may be due to his inexperience, that we have not more ample details of the manners, customs and

ways of the people he came across; but it is probable that had he recorded his notes in his own vernacular, in place of employing the medium of English, he could have given us the result of his observations more fully than his limited knowledge of English permitted.

The experience he has now gained, will, no doubt, serve him well in any future work of this kind, and will justify the expectations which have been formed from this first attempt to survey in such an elevated region as Eastern Tibet; where the frost and cold for lengthened periods are so intense and the marches so laborious and wearisome, that they might well frustrate the successful accomplishment of an unbroken traverse of over 2,000 miles in length, stretching across no less than 24 degrees of longitude.

This, however, was what he accomplished, and the following are his notes on the journey.

Notes on a Journey from LANAK PASS *in* CHANGTHANG *to the* WESTERN FRONTIER OF CHINA, *through* TIBET, *by* ATMA RAM.

We started from Lanak plain (in Changthang), which is surrounded by low hills and where we found the water frozen every where, on the 3rd July 1891, and reached Shum the same afternoon, after crossing the low pass of Lanak and entering a plain in which Shum is located.

On the day following we crossed over another pass, elevated about 18,000 feet above sea level; then crossing several streams we arrived at a place called Tobomarpo, situated in a plain. We next marched along a stream and through a plain to Kalung, situated to the south of a salt lake, a place where the wind always blows strongly. A little snow fell this day. Up to this place we experienced no want of grass, which was growing everywhere, but no fuel could be obtained here, and we were obliged to use *argol*, or the dried droppings of animals, for burning purposes.

Our next march on the 6th, through a sandy tract, took us in a north-easterly direction, to a very beautiful spot known as Papuk, which is situated near the Mangtza Chho lake and surrounded by very fine scenery. We here found a low dry shrub, called *burche*, which we used as fuel. After halting on the 7th at Papuk, we marched on the day following to Khangmar, situated to the south of the Mangtza Chho lake and near a hot spring. We marched on the two succeeding days to Sammar and to Chorimar, the latter situated on the western shore of the Horpa Chho lake. On this last march we noticed that antelope abounded. On the 11th we skirted the shore of the above mentioned lake and camped to the south of it, at an elevation of about 18,020 feet, and then on the 12th after following an easterly bearing for some miles, we altered our direction to the south-east, to a place called Cholong.

Our next march took us over a pass elevated about 18,520 feet above sea level, to Tangnek, a place situated near the north-western shore of the large lake of Charol Chho, where we found fuel very scarce and the wind blowing very high. On the 15th we travelled along the northern shore of the lake and camped at Chamit Charol, where we found plenty of grass. Next day to Khamba Thoksa, where Captain Bower took observations for latitude, and on the day following we made a short march to Khambul, where for the first time on this side of the Lanak Pass, we saw nomad encampments, and engaged men as guides. From Khambul we marched to Rarupka, situated near a small stream, and the next day, after ascending a comparatively easy pass, we encamped at Gakchi, situated at the foot of another pass, which we crossed the day after, the 20th July, and then followed on to Aru, near the western shore of a large lake called Aru Chho, elevated about 17,100 feet above sea level. At all these places water was plentiful and good, but wood for burning was scarce, and we had to resort to *argol* for fuel.

Our next march lay through an extensive grassy plain, on which a great variety of flowering plants seemed to flourish, and where the wild yak and numerous antelope roamed about freely, and we camped at a place called Arurapka, situated at the foot of snow mountains. On the following day, the 22nd, we journeyed due east, leaving the Aru Chho and another smaller lake on either side of the route, to a pass which we ascended, and camped near, for the night. A tarn, containing a little dirty water, supplied our wants in this line, and we found *argol* for burning. A road leads off from this place towards Lhasa.

On the 25th July, we reached a very fine spot, situated in a wide open valley, after having passed *en route* some lakes and a spring of water. During these last three marches we found plenty of water, but fuel was scarce. After a halt at the last camp, owing to a fall of snow, we continued our march in a south-easterly direction, camping in a wide valley on two successive nights, and after crossing a low watershed, we reached a spot at the foot of some hills where, in consequence of our baggage animals having strayed, we stopped till the 3rd August. During these marches fuel and woter never failed us, but we were not a little inconvenienced by repeated falls of snow. Our elevation here was about 17,080 feet above sea level. Several of our baggage animals were lost and we had to do the best we could without them. At this place Captain Bower took observations for latitude. On the 4th August we broke up camp and continuing in a south-easterly direction, we arrived at a spot near a stream which empties itself into a lake to the north-east, having camped mid-way on the previous night. We found the tract we had traversed to be a waterless one, but here we discovered water and a little green grass

to cheer us, and the dry droppings of animals supplied us with fuel for burning. We halted here on the 6th to recover our baggage animals, which had again strayed away. Another long march on the 7th through a grassy valley, brought us to a spot near a stream which empties itself into the lake mentioned above. We were in much want of something to burn at this place and to add to our discomforts, a storm broke over our heads, and deluged our camp. Captain Bower observed for latitude here, which we ascertained to be in elevation about 16,080 feet.

Five marches, varying in length, on a south-easterly bearing, crossing two elevated passes and passing lakes on either side of our route, brought us to a spot in an open valley, where Captain Bower again observed for latitude on the 13th August. On these marches we found water and fuel plentiful, while there was no want of excitement afforded us in the pursuit of game, which abounds in this tract. Yaks, antelope and ducks were seen in large numbers. Traces of men were also noticed.

On the 17th August, after having made four additional marches, through low hills, over two passes, crossing streams and passing a few lakes, we reached a nameless spot in a plain, which we found by observations to be elevated about 16,650 feet; this also was a latitude station. Everywhere on these marches water was plentiful and there was fortunately no want of fuel. Leaving our last camp on the 18th we marched for five days over passes elevated above 17,000 feet, encamped near streams, passed lakes, and on the 22nd we stopped near a small lake where Captain Bower observed for latitude. On this tract we found water everywhere, and fuel was forthcoming in sufficient quantity for our wants. Here we had evidence of men having been before us. The elevation of this camp we found to be about 15,550 feet.

On the 23rd we made a short march, of about 6 miles, to a place near a small stream, where we found sufficient grass for our wants, but fuel was scarce. Here we halted the next day, because we heard that some Champa people were encamped in the neighbourhood, from whom we wanted information, regarding the country, etc. We were not well received by them, however, their jealousy and suspicion having evidently been aroused.

On the 26th we came across a party of Dokpa people who were grazing their cattle, and they obligingly sold us *satu*, salt and sheep. These men wore big hats as a protection from the sun. On the day following, we made a very short march of about 4 miles, to a spot called Sira Nagmo. Two marches more brought us to a place called Zita, situated near a stream, in a plain, after having crossed a pretty considerable stream flowing northwards to a large lake called Chuksi Chho, and said to have a circumference so large, as to occupy a man seven days in walking round. There was no want of grass in this track, but fuel was scarce. The elevation of Zita we found to be about 14,620 feet.

On the 30th August, after crossing two low passes, we arrived at Ratha, a place situated on a small stream which empties itself into a lake to the south. Whilst we were camped here, a party of mounted Dokpas insolently addressed us, forbidding us to leave the spot, till orders were received from higher authority, concerning us. They were soon made aware that their instructions were not going to be complied with. The country we had now traversed, from the Lanak Pass, was treeless, though in places we found a dry bush called *burche*, which we used whenever we could, as fuel, but *argol*, chiefly of the yak and antelope, we found in sufficient quantity to use as fuel. I do not remember seeing any birds throughout this tract, which is known as the Chang. Five marches of varying lengths, from Ratha, over passes, crossing minor streams, through valleys, and skirting lakes, brought us to a spot known as Sitong, where we camped; this was one of Captain Bower's latitude stations. Throughout these five marches, we received decided opposition from the Dokpas, who inhabit these parts, living in tents made of black wool. These men did all in their power, short of physical force, to dissuade us from travelling towards Lhasa, where they sent men to inform the authorities of our approach. Sitong is situated near a stream that flows into the large lake, called Naksung Satu. Several hot sulphur springs exist in this locality, which is elevated about 15,520 feet above the level of the sea. Robbers roam about these parts.

Two more very long and fatiguing marches, skirting the southern shore of the Naksung Satu and Garing Chho lakes, brought us to a place known as Gagalinchin, elevated about 15,560 feet. These two names, Naksung Satu and Garing Chho, are given to the western and eastern halves of one very large salt lake. It is said to be twelve days' march round it. We reached this place, Gagalinchin, on the 7th September, and owing to the determined opposition we received, it was agreed that we should stay here till orders were received from Lhasa. Those orders came shortly and finally stopped the continuation of our march in the direction of Lhasa, so we were obliged to abandon that project, and retracing our steps on the 4th October, we reached Lama-karmo on the 9th, a place situated on the route we had traversed. During our detention at Gagalinchin, we experienced falls of snow on several occasions. Lama-karm, the place we reached on the 9th October, is near the south-west corner of the Chargat Chho lake, from whence we could see snow mountains, lying both to north as well as south. Here we stayed on the 11th and following day, to replenish our stock of provisions.

The next day we marched northwards, along the western shore of the Chargat Chho lake, to Uruni. A curious white rock, called Shamo Atsag Jamo (Shamo's helmet) stands clear out of the water of this lake, near Uruni. I may here explain that Shamo is traditionally said to be one of the ancient warriors of these people.

Our next three marches were in a northerly direction, to Moga Pishor, situated in an

extensive plain, thence to Hormo Sachuk at the foot of a pass, which we crossed, and then to a spot on a small stream which flows into the Chajing Chho lake. In this tract we came across Champa encampments, for grass was growing luxuriantly everywhere. Pursuing still a northerly bearing, we camped on the 17th, at Taglagapo, passing *en route* two *manephanes*, or piles of stones, having the religious formula of the Tibetans, "om mane padmi om," engraved on them. The next day we crossed a very high snow range at an elevation of about 18,760 feet, and descended to Mugatip, where we camped.

Leaving our last camping ground on the 19th we travelled on to Zokh, passing *en route* a very remarkable rock. We then pushed on through an extensive plain to Potocho, where we camped and halted the next day, owing to our baggage animals having strayed away over night. On the 22nd October we left Potocho and marched to Ten Kum Song, passing some lakes and several caves, which afford shelter to travellers; and then on the day following we ascended a pass, and crossing, descended to Iring-khade, where we camped for the night. The next day we marched through a wide open valley or grassy plain to Khokhung Chhaka, elevated about 15,860 feet above sea level, and almost entirely surrounded by very high snow mountains. Up to this place we had travelled almost due north from Lamakarmo, but now we were to pursue a due easterly bearing.

Our next eight marches were uneventful, and were one and all, in a due easterly direction from Khokhung Chhaka. At first we marched through a grassy plain to Shegar Khung Long, and then crossing a rather elevated pass, about 17,700 feet above sea level, we camped at Shegar Shar Long, leaving a lake on our right hand. We then skirted the Tau Chho lake, and halted for the night at Pading. The following morning we skirted another lake, then ascended a pass, and camped for the night at Kong Thong. Pursuing our journey the next day, we traversed a plain, crossed a pass, and camped for the night at Singi Opo. The following day we camped at Ghagasar, passing *en route* several small streams, which drain into a lake, and then marched to Yagmo and Nazu Zir, where Captain Bower took observations for latitude. In the neighbourhood of Yagmo there exists a rather large salt lake, around which herds of yaks graze, attracted no doubt by the salt licks, which are known to be in the locality. All the surrounding population carry away salt from the mines that exist near Yagmo, which is elevated about 16,110 feet above sea level. Nazu Zir is surrounded by low hills. We never felt any want of grass for our animals throughout this tract of country, and we were fortunate enough to secure sufficient *argol* for burning purposes. It is evident that this has been a well known route, for on the top of the pass near Shegar Khung Long we observed a *manephane*, or pile of stones, with "om mane padmi om" engraved on them.

On the 5th November we marched to Khurlu Mata, situated on a small stream, and on the following day we crossed a pass, and entering a wide valley, we camped on a stream flowing to the east. Many snow peaks were visible on this march. The next day we followed the same stream on which we last camped, passing on either hand, low red coloured hills. During the last three marches we felt no want of grass or *argol*.

Three marches more, after crossing several passes, and hearing of nomad encampments in the neighbourhood of our route, we arrived at a place called Bongro, elevated about 15,380 feet above sea level, and where we learnt that bears were to be found. Grass on these marches is abundant. On the 15th November, after making four marches of varying lengths, we reached a place called Garthe, situated on a stream which flows into the Chonak Chho lake. On these marches we crossed several passes and streams, and came across Dokpa encampments. We halted at Garthe on the 16th in order to purchase, if possible, some yaks for transport purposes.

On the 17th we made a rather long march, and on the 18th we reached Khokink, near which place there were Dokpa encampments. These Dokpas are subjects of China. On the 19th we marched to Data Cho and on the 20th we camped at Pongro, which is surrounded by hills, after passing several *manephanes*, or piles of stones. On the 21st after crossing a pass, we arrived at Atak-Memar, passing *en route*, Kozong and Sharuring, two places which were occupied by Dokpas. On the 22nd we reached Shathama Chichong. It was on this march that we crossed the route taken by A-K., when he travelled from Lhasa to Saitu, during 1879-82. The elevation of Shathama Chichong is about 14,320 feet above sea level.

Six additional marches, some of which were very long, took us to a place called Pongra, where Captain Bower observed for latitude. On these marches we ascended passes, crossed streams, saw many snow peaks around us, and encountered several Dokpa encampments and passed *manephanes;* but besides a fall or two of snow, no particular adventure occurred. We found the elevation of this place to be about 14,920 feet. After making a day's halt at Pongra, we made a long march to a place situated in the midst of hills, from where snow peaks were visible. Here we noticed forests of pine on the hills adjoining our route, as well as several nomad encampments. We learnt also of the existence of bears, jackals and pigeons in this locality.

On the 1st December, we made a short march to a place near Tsuk-Sun-Dong-Gong Gomba, or monastery, where two high officials, called Yong and Lama, respectively, reside. Here we found well built wooden, painted houses, and each house displaying a flag at the end of a long pine pole. Four important roads meet at Tsuk-Sun-Dong-Gong, which contains about 500 houses and is evidently a place of some importance, from all that I could find out, and plays its part in the government of the surrounding country. Two marches more brought us to Nirchumgi sarai, where Captain Bower took observations for latitude.

On the 4th December we marched to Pongmar Thong, situated on the Ircho river, and on the 5th another march took us to Longonpho, after crossing numerous streams, and a pass elevated about 15,000 feet above sea level. After a halt of a day at our last camp, we marched to Yangmando, situated near the Zichu river, passing several encampments. This place is under Chinese rule. Another long march, on the 8th, took us to the large village of Richando, where we saw patches of cultivation. This place is about 13,220 feet above sea, and is situated at the foot of a small hill near the Thomcho river.

On the 9th December we made another long and very trying march to Pata Samdo sarai, near a stream and surrounded by hills. We crossed several passes and streams on this march. Here again Captain Bower took observations, and from here many snow peaks were visible on all sides of our camp. On the 10th we halted at Pata Samdo, and on the day following, we marched to Malanzi, situated at the foot of a red coloured hill, near a stream, crossing the Ma La pass and several streams. Not many encampments existed on this march. On the 12th we journeyed to Vanzomda, near Sari Samdu, situated on a stream which flows into the Sachu river, which latter is bridged. We noticed patches of cultivation, for wheat, barley and vegetables are what the people cultivate in this part of the country. A place called Chanba Gomba lies a little lower down the Sachu river.

Our next march was to Jogor Thong, a latitude station. Several villages were passed *en route*. Here we halted on the 14th, owing to the desertion of our guides. The day following, we reached the large village of Tashi Ling Gomba, containing about 700 houses, and situated near a stream, which empties itself into the Chimchu river. We passed numerous habitations and the tract appears to have a pretty considerable population. The elevation of this place is about 12,820 feet.

On the 16th we made a very long march to Khemo Tinchin, situated on the Komcho river, where we found a large population, in a place containing about 500 houses. Wheat is cultivated in this locality. Our next march was a short one, to Khembo Nar, through a thickly populated tract, and on the following day, we resumed our route to Khembo Chahu. The inhabitants along this march are thievish by custom and impudent in manner. On the 19th we marched to Khemoyok, situated on a stream which flows into the Barazonchu river, and on the day following we reached Maru, the residence of a Lama, situated near a wooden bridge over the Tasichu river, and near a *manephane*, where Captain Bower took observations for latitude. The country on this march was well populated. We had warning given to us that this place was noted for thieves, and that they intended to rob us. In consequence of this warning, we prepared to receive them, but the night passed uneventfully. There are two religious sects amongst this people, one called Pandi and the other Ponbe.

Four more marches, after ascending several passes, crossing numerous streams and passing through pine forests, and a thickly populated country, brought us to Poshi Thong, situated on the Zichu river and in a valley surrounded by pine forests. On the last of these four marches, we passed Rinchi monastery, a place of considerable size and importance. In the forest we passed *en route*, musk deer and pheasants are to be found. After halting one day at Poshi Thong, we made a very long march to Rocham Thang, situated on the Zichu river. On this march we passed some iron mines. The elevation of this place is about 12,500 feet.

Four more marches of varying lengths, brought us to Guru, where we arrived on the 30th December. Several villages were passed, and at some of our halting places, the people asked us to show our passport. The Zichu river, along which our first two marches ran, is bridged in several places. The hills on either side of our route were covered with forests of pine, including both the *longifolia* and *excelsa* species. Several officials approached Captain Bower at Guru, and asked us many questions regarding our intentions, and enquiring if we possessed a passport to travel in these parts. These men tried to intimidate us and attempted to prevent us from journeying onwards to Chiamdo, saying that no Englishman had travelled here before. The elevation of this place we found to be about 11,100 feet.

On the 31st December, we marched to a place called Epwa, situated a few miles beyond the City of Chiamdo, which latter is a centre of great importance. It is densely inhabited and possesses several fine *gombas* or temples. Chiamdo is situated at the junction of the Namchu river and a stream that flows from the west. At Epwa, Captain Bower took observations for latitude, and fixed its elevation at about 11,840 feet. We halted at Epwa on the 1st January 1892, and on the following day made a long march to Pandesar, in which there is a house set aside for the accommodation of Chinese officials travelling between China and Lhasa. Barley and wheat are cultivated at this place. On this march we passed a pine forest. The elevation of Pandesar is about 12,720 feet. Six marches of varying lengths, some long and wearisome, through a well populated tract, brought us to Garing Doba, where Captain Bower took observations for latitude. This place is a part of the country where the people are independent of both China and Tibet. On these marches we ascended several passes and crossed numerous streams, and saw forests of pine on either side of our route. This part of the country is inhabited by Dokpas and Khatis, or a mixed race.

On the 14th January, after making five marches, we reached Monkong Garthok, a place previously visited by explorer A-K., and called by him Garthok or Makham, situated on the Mongothongchu river. On these marches we crossed several passes and met with numerous well populated villages. Pine forests were seen on the hills, on either side of

our route. At certain intervals in this part of the country, there are houses set apart for the accommodation of Chinese officials, when travelling between China and Lhasa. We halted at Monkong Garthok on the 15th January.

We next marched to a place called Phula, situated on the Mongothongchu river, and surrounded by hills covered with dense pine forests. Here we learnt that Prince Henry of Orleans and M. Bonvalot had travelled over this route. We were now at an elevation of about 12,420 feet. On the 17th, we reached Lande (Lhamdun of A-K.), a pretty large place, inhabited by Khatis (a mixed race of Chinese and Tibetans). *En route* we crossed several passes, and skirted many villages and pine forests. Several snow peaks were visible hereabouts. Our next march was to Bon, a place situated at the foot of the Bomba La Pass, from whence eastwards, the country is under the rule of China. Several villages were passed on this march, and the whole tract is thickly populated.

On the 22nd January, we reached Ba or Bathang, situated near the left bank of the Dichu river, after making four marches, first to Khonjika, then crossing the Dichu by ferry boat to Tuana or Dubana, then on to Lah and lastly to Bathang. Bathang possesses a big monastery or *gomba*, surrounded by a wall. The river Bachu, near which we camped, is spanned by a wooden bridge, and on the opposite side of the river, is a village. The population of Bathang is made up chiefly of Khatis, with a sprinkling of Dokpas.

I had an opportunity of witnessing how criminals were kept in confinement here. These poor creatures have instruments like the stocks applied to their necks. The people of the place told us, that about two years ago, two Frenchmen (M. Bonvalot and Prince Henry of Orleans) visited Bathang, and remained in the *sarai* two days. We saw the words "vive la France" written by one of them on the wall of the *sarai*. Horses are used here for ploughing the fields.

On the 25th January, we left Bathang and marched to a small village of 5 or 6 houses called Pongotomo (Pangthamo of A-K.), situated on the Bachu river, and near the foot of the Tag La Pass. A fine forest of pines exists in the locality. *En route* we noticed several snow peaks and passed many hot springs and a few small villages. Our next march was to Tashu, after crossing the snow pass of Tag La. Tashu contains 7 or 8 houses and a few nomad tents, and is a very cold place. We passed on either hand snow ranges and peaks, and also fantastically shaped, whitish hills, covered with forest. Elevation about 13,140 feet.

On the 27th, we marched to Rathi, a small village consisting of about 7 or 8 houses, situated in a valley surrounded by hills. At first our route ran along the Tashuchu river, and then left it, and after ascending the Lathok La Pass, we descended to our camping ground, from which some snow peaks were visible. Fine forests of pine exist on the hills bordering our route, from Bathang to this place; but the people of the country wantonly destroy the trees.

Another march of ordinary length brought us to Namda, (Naida of A-K.), a small village elevated about 12,790 feet, from whence several snow peaks were visible. On this march we noticed only a few nomad tents, but numerous *manephanes*. The people here are very superstitious, and believe they can obtain the salvation of their souls, by marching round the snow ranges that exist in this part of the country.

Three marches more, after crossing several passes and streams, brought us to Lithang monastery, a place of considerable importance and inhabited by Khatis and Dokpas. It is situated on a stream flowing through a valley and is surrounded by hills. As we arrived at Lithang, some men approached us with stones in their hands, evidently bent on mischief; but as a counter move, Captain Bower took up his gun; on seeing which the cowards fled. Lithang possesses a *kotwali* or *kacheri*.

Our next march was to a small village called Horchuka, or Hapchukha, after crossing the Damado La Pass, and passing some places where the inhabitants dig for gold. A crude method of washing the gold is adopted. On the 2nd February, we marched to Thamo Rothang (Tamarathong of A-K.), a very cold place, elevated about 12,980 feet above sea level, and surrounded by forest. *En route* we crossed two passes, and passed some houses and a few nomad encampments. All the way from Lithang the cold was intense. Our next march was to Galuk (Golokthok of A.-K.), a large place and well inhabited. Throughout this march, we observed forests on either side of our route. On the 4th, we marched to Lanipa, a small place, situated at the foot of the Dosa La Pass. We passed a *gomba* or temple *en route*. Forests extend the whole way. Leaving Lanipa, we marched on the day following, to the right bank of the Nagchu river. On the opposite bank (which is reached by a bridge of boats) stands the village of Nagchuka, where A.-K., had observed for latitude. After crossing the Rama La Pass, we made a very great descent to the Nagchu river, and found the place very warm. The whole way from the pass our route ran along a stream, and on either side, the hills were covered with dense forest. We saw, for the first time in our travels, monkeys and squirrels at this place.

Our next march on the 6th, took us to Urong Dongu, a rather large place, and then on the 7th, we reached Mina Galuk (Golokthok of A.-K.) situated near a stream and densely populated. On this march we crossed the Kashi La Pass, from where we saw several snow peaks on all sides of us. Two French missionaries live here, but they were not at home when we arrived. They resided at first at Bathang, but about three years ago they left that place for Mina Galuk. Our next camp was at Amia To, or Amia Gachak (Amya Giachuk of A-K.)—*To* means a house, and *Gachak*, a place. This is a large place and thickly populated. Snow fell during the night. We passed many villages on this march.

On the 9th February, we crossed over the Zila La, or Gi La Pass, and camped at a small place called Chitu. The spot is a beautiful one, and is surrounded by hills covered with forest. On the top of the Gi La Pass, I met a French missionary, travelling to Mina Galuk, and he put me some questions; asking if I spoke English and where I came from. After a little talk, we parted.

On the 10th February, we marched into Ta Chen Lu (A-K's Darchendo), which is known also as Tarsedo, or Gia Tentsi. It is situated in a valley surrounded by very high mountains, and is entirely under the rule of China. It has the reputation of being unhealthy, and we concluded that this was due to the existence of a cemetery on the hill above the city, near which is a spring of water (used by the people for drinking) which flows down to the river. The people keep their houses clean and comfortable, and use chairs and tables, and are, as a rule, civil and obliging. Ta Chen Lu is a large trading city, and is a large mart for tea, in which commodity a brisk trade is carried on. The houses here are almost all built of timber. We halted here, up to the 24th February, and almost every day of our stay we experienced falls of snow.

Notes by COLONEL HOLDICH, R.E., *on the preparation of* CAPTAIN BOWER'S *route maps of exploration in* TIBET AND WESTERN CHINA.

The plotting was first executed on graticule sheets on the ½-inch scale, starting from Lanak Pass, the position of which was taken from the Atlas of India, sheet No. 63A., N. W. Lanak Pass is in Changthang and over a spur from the well known Chang Chenmo range.

The first point of contact with any previous explorer's route was at Ata, on explorer A-K's route from Lhasa northwards; and as it was assumed that the position of that place as fixed by A-K., could not be far from correct (lying as it does, not very distant from Lhasa, which is a fairly well ascertained position, and north by east of it) its longitude was retained.

Captain Bower's position of Atak Memar (A-K's, Ata) is after adjustment of the traverse with his observed latitude of the place, in latitude 31° 58′ 39″ and longitude 92° 23′ 0″ whilst A-K., makes it in latitude 32° 2′ 40″ and longitude 92° 5′ 45″, giving a difference of about 4 miles in latitude and 17 miles in longitude. This must be considered a very fair agreement considering that 1,100 miles of ground, running nearly east had been traversed, and a rate of pacing had to be assumed at 2,200 paces per mile.

Atma Ram's traverse from Lanak Pass to Atak was made to fit in between those two positions and finally adjusted in sections between the camps, fourteen in number, where Captain Bower had observed for latitude.

The next point of contact of Captain Bower's route, after leaving Atak, with any previously well established position, was at Garthok, again on A-K's route, situated not far from, and south-west of, Bathang.

Captain Bower's position of Garthok after adjustment with Atak is in latitude 29°40′28″ and longitude 100°34′20″, whilst A-K. made it in latitude 29°41′7″ and longitude 99°7′50″ showing a difference of about 86 miles in longitude, due evidently, to having assigned too great a value to the length of a pace in the projection of this section of the plot; for in place of employing 2,200 paces to a mile, a scale of about 2,500 paces to the mile would have resulted in a better agreement in the position of Garthok.

The alteration in the length of pace was owing to the change in the character of the country after crossing A-K's route; the rounded hills and open valleys that had been the characteristic formation generally, changing into sharply defined mountain valleys, much cut up by ravines. A good portion of this section was traversed by M. Bonvalot also.

A-K's longitude of Garthok was retained and the traverse between Atak and Garthok was interpolated and finally adjusted in sections between the camps, eight in number, where Captain Bower had observed for latitude.

For the remainder of the route, the positions of Bathang and Darchendo, as deduced by A-K., who agrees closely with Captain Gill's determinations, were retained, and Atma Ram's traverse (which here also proved to be too long) was adjusted to them.

Remarks.

(*a*) Pacings employed in plotting, 2,200=1 mile.
(*b*) Length of traverse from Lanak Pass to Yatu=2,080 miles.
(*c*) The route was traversed by Sub-Surveyor Atma Ram.
(*d*) Captain Bower's latitude observations were reduced at the Trigonometrical Branch Office at Dehra Dun.
(*e*) The heights were deduced from boiling point (hypsometrical) observations and must be considered approximate only.
(*f*) Magnetic variation east + compass error= +4°.
(*g*) All bearings were taken with a prismatic compass.

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

Statement showing the work performed during the year 1891-92.

TITLE.	Number of Sheets.	Scale.	REMARKS.
Atlas of India.		Miles per inch.	
Sheets Nos. 12 N. E., 12 S. E., 16 N. E., 16 S. E., 30 S. E., 31 N. E., 36 N. W., 42 S. W., 59 N. W., 87 N. E., 87 S. E., 88 S. E., 102 S. W., 102 S. E., and 131 S. E. . . .	15	4	Additions to names and outline for engraving.
Sheets Nos. 22 S. E., 23 S. E., 25 S. E., 26 N. E., 35 S. W., 36 S. W., 38 S. E., 38 N. W., 40 N. W., 40 S. W., 42 S. E., 49 N. W., 59 S. W., 60 N. E., 60 S. W., 60 S. E., 61 N. W., and 89 S. E. . . .	18	4	Hills brush-shaded for engraving.
Sheets Nos. 22 N. E., 22 S. E., 35 N. E., 35 S. E., 39 N. E., 39 S. E., 53 S. E., 53 S. W., 60 S. W., 61 N. W., 71 N. W., 71 S. W., 71 S. E., 72 N. E., 72 S. E., 72 S. W., 87 S. E., 90 S. E., 90 S. W., 91 S. W., 102 S. W., 105 N. E., 105 S. E., 126 N. W., and 126 S. W. .	25	4	Additions to railways, roads, canals, and changes in boundaries.
Sheets Nos. 14, 29, 37, 40, 54, 56, 58, 59, 60, 61, 65, 67, 76, 77, 78, 79, 89, 102, 106, 111, 112, 114, and 116.	23	4	Ditto ditto.
General Maps.			
India (engraved) . . .	6	32	Additions to railways and boundaries.
Do. do. (skeleton) .	6	32	Additions to names and outline.
Do. do. . . .	4	64	Additions to railways.
Do. do. . . .	1	96	Corrections to boundaries and railways to March 1892.
Do. do. . . .	1	128	A new compilation; completed.
Do. do. . . .	1	128	Railways to date.
Do. do. . . .	1	256	Ditto.
Do. (lithographed) . .	6	32	3rd edition; additions to date.
Do. do. . . .	2	32	3rd edition; hills brush-shaded.
Do. do. (railways) .	6	32	3rd edition; additions to date.
Do. do. do. (skeleton)	6	32	Additions to date.
India (lithographed) do. (skeleton)	4	48	Corrected to date.
India (lithographed) do. (skeleton)	1	128	Additions to date.
Burma and adjacent countries .	2	32	2nd edition, corrected to date.
Do. do. . .	1	48	Ditto ditto.
Afghanistan	2	24	Additions to railways.
Provincial Maps.			
Burma (Upper) . . .	3	16	A new compilation in progress.
Gujrat	1	16	Additions and corrections to dates.
Bengal, Behar, Orissa, and Chota Nagpur	2	16	A new compilation; completed.
Central India Agency . .	2	16	Additions to date.
Punjab	4	16	Additions to railways.
Nizam's Dominions . . .	2	16	Corrections to boundaries.
N.-W. Provinces and Oudh .	2	16	Additions to date.
Mysore	1	16	Ditto.
Bengal, Behar, Orissa, and Chota Nagpur	2	16	Additions and corrections to date.
Sindh	1	16	
Rajputana Agency . . .	2	16	
Assam	1	16	
Mysore	1	16	
Central Provinces . . .	2	16	

DRAWING OFFICE, CALCUTTA.

SECTION I.

Statement of work.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		Miles per inch.	
Divisional Maps.			
Chota Nagpur	8	4	A new compilation, in progress.
Orissa	4	4	Ditto ditto.
Agra	1	4	Additions to railways and corrections to boundaries.
Lucknow	1	1	Ditto ditto.
Allahabad	1	4	Additions to railways.
Meerut	1	4	Additions to railways and corrections to boundaries.
District Maps.			
Shahabad, Sylhet and Kamrup, Dinagepur, Bhagalpur and Purnea, Champaran, Saran, Purnea, Tippera, Lohardaga, Palamau, Bogra, Backergunge	12	4	Additions to roads and corrections to boundaries.
Mymensingh, Nadia, Ulwar State	3	4	Additions to roads and corrections to boundaries.
Standard Maps.			
CENTRAL INDIA AGENCY AND RAJPUTANA—			
Sheets Nos. 408, 421, 449, 474, 482, 483, 429, 450, and 480	9	1	In progress.
Sheets Nos. 396 and 480	2	1	Completed to margin.
Sheets Nos. 135, 136, and 137	3	1	Additions to railways.
Sheets Nos. 238, 239, 269, 270, and 334	5	1	Additions to roads.
BENGAL—			
Sheets Nos. 13, 14, 20, 21, 80, 89, 90, and 91	8	1	Roads inserted.
Sheets Nos. 62, 65, 92, and 95,	4	1	Ditto.
Sheets Nos. 110, 141	2	1	Additions to railways.
MADRAS—			
Sheet No. 151	1	1	Completed to margin.
Sheets Nos. 150, 152	2	1	In progress.
CENTRAL PROVINCES—			
Sheets Nos. 11, 12, 14, 15, 18, 29, 30, and 38	8	1	Additions to roads.
Sheets Nos. 4, 10, 16, 19, and 23	5	1	Additions to roads and railways.
MYSORE—			
Sheets Nos. 57 and 58	2	1	Additions to railways.
HYDERABAD—			
Sheets Nos. 18, 56, 57, 80, 84, 106, 128, 129, 130, 132, 152, 153, 154, 155, 156, 169, 171, 172, 173, 174, 185, 186, 219, and 221	24	1	Roads inserted.

DRAWING OFFICE, CALCUTTA.

SECTION I.—*continued.*

Statement of work.—continued

TITLE.	Number of Sheets.	Scale.	REMARKS.
Standard Maps—(continued).			
BOMBAY SURVEY—			
Sheets Nos. 153, 154, 202, 234, 235, 236, 266, 267, 269, 270, 279, 280, and 297 . . .	13	1	Roads and canals inserted.
UPPER BURMA (NORTH-EAST FRONTIER SERIES)—			
Sheets Nos 15 N. E. (2nd edition), 15 S. E. (4th edition), 23 N. W. (5th edition), 23 S. W. (6th edition)	4	4	Additions to date.
Sheets No. 22 S. W. (2nd edition)	1	4	Completed.
Sheets Nos. 15 (4th edition), 22 (3rd edition), and 23 (2nd edition)	3	8	Ditto.
Supplement to Sheet No. 15 N. E	1	4	Drawn.
UPPER BURMA (SOUTH-EAST FRONTIER SERIES)—			
Sheets Nos. 1 N. W. (2nd edition), 1 S. W. (2nd edition), 1 N. E. (4th edition), 4 N. W. (4th edition), N. E. (3rd edition), 4 S. W. (5th edition), 4 S. E. (3rd edition)	7	4	Additions to date.
Sheets Nos. 1 (4th edition), 3 (3rd edition), 5 (1st edition) . .	3	8	In progress.
Sheets Nos. 2, 4, and 6 . .	3	8	Completed.
Administration Report Maps.			
Palamau	1	12	A new compilation.
Jhansi	1	12	Corrected to date.
North-Western Provinces and Oudh	1	40	Ditto.
Rajputana Agency . .	1	64	Ditto.
Ajmere and Rajputana .	1	8	Ditto.
Assam	1	24	Ditto.
Index Maps.			
For Annual Administration Report	5	Various	Drawn.
For Annual Administration Report	11	Various	Corrected to 30th September 1892.
Miscellaneous.			
Mu Valley State Railway .	1	1	A tracing prepared.
Map of Pachmari and surrounding country	1	2	Prepared for His Excellency the Viceroy of India.
Tirhoot State Railway . .	1	1	A tracing prepared.
North-West Frontier Road from Latamar to Pezu . .	1	1	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION I.—*continued.*

Statement of work.—continued.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		Miles per inch.	
UPPER BURMA (SOUTH-EAST FRONTIER SERIES)—*contd.*			
Triangulation Charts.			
Ganjam and Orissa Topographical Survey	1	4	A tracing prepared for re-production.
Chin-Lushai Expedition	1	4	Re-drawn; completed.
Work done for other Departments.			
BENGAL—			
Police	4	80	Showing different crimes.
Mortality	4	80	Showing fatal fever, cholera, and small-pox during 1891.
Income Tax	3	80	Showing (1) distribution, (2) proportion of persons assessed, (3) incidence of taxation in 1891-92.
Revenue	6	80	Different maps showing sources of Excise revenue.
Emigration	2	96	Showing districts of emigration and registration.
Revenue	1	16	Showing saliferous districts.
ORISSA DIVISION—			
Revenue	1	16	To illustrate Salt Administration Report.
ASSAM—			
Revenue	1	48	Showing rate of increase and decrease of population.
INDIA—			
Emigration	1	96	Showing registration districts.
"	1	96	Showing the Native districts of Colonial Emigrants.
Maps of Kashmir and parts of Afghanistan, Punjab, and adjacent countries, Persia, East Coast of Arabia, Sind, and Baluchistan and Bombay	6	32	Prepared for Aitchison's Treaties.
Map of Siam	1	32	In progress for ditto.
Postal Map of the Province of Bengal, 1892	12	8	Additions and corrections to date.
Postal Map of the Eastern Bengal Circle	8	4	Drawn and completed.
Map of the Gangetic Alluvium	2	128	Ditto ditto.
Sketch illustrative of the action of Najufgurh	1	...	Drawn for the Director of Records to the Government of India.
Map of India to illustrate the History of the Mutiny in 1857	1	128	
Sheet No. 4, routes in Northern Somali land	1	6	Drawn for Captain Swayne, R.E.
Reduced plan of the routes reconnoitred in Northern Somali lands	1	16	
Road, Sketch, Lower to Upper Sheikh	1	4	
Map of 10 miles round Berbera	1	1	
Sketch Map of the Somali country, showing the approximate position of the "Haud"	1	...	
Sheets Nos. 1, 2 and 3, routes in Northern Somali land	1	6	
Sheets No. 1, 2, 3 and 4, routes in Northern Somali land	1	4	
India showing Railways with Stations	2	64	Drawn for the Director-General of Railways.
Maps Coloured.			
Maps on various scales	340	...	For Surveyor-General's Office.
Ditto ditto	83	...	For other department.

DRAWING OFFICE, CALCUTTA.

SECTION I—*cantinued.*

Statement of work—continued.

Description of work.	Number of Sheets.
Maps examined.	
Atlas sheets	34
General maps	20
Provincial maps	16
Divisional maps	1
District maps	7
Standard maps	35
Administration Report maps	9
Index maps	7
Statistical maps	55
Triangulation charts	1
Miscellaneous maps (departmental)	4
Ditto (extra-departmental)	35
Office copies of various maps, with additions and corrections in territorial boundaries and public works	267
Engraved proofs of atlas sheets in various stages	119
Engraved proofs of general and provincial maps, including index charts	55
Engraved proofs of district maps	27
Litho. proofs of general and provincial maps, including index charts	23
Litho. proofs of district maps transferred from copper-plates	13
Litho. proofs of extra-departmental and statistical maps	29
Photo. proofs of standard maps, large scale plans, and various other maps	455
Colouring of maps for various purposes	178
Tracings of maps for various purposes	22
Projection and examination of graticules and plotting of points	45
Total	1,457

N.B.—In addition to the above, many miscellaneous jobs, such as supply of geographical data to various officials, calculation of areas, computation of graticules for the projection of the sheets of the Indian Atlas, examination of the proof sheets of the Survey of India Notes, as to the correct orthography of geographical names, etc., have been performed by the Examining Section.

DRAWING OFFICE, CALCUTTA.

SECTION II—REVENUE.

Statement showing the work performed during the year 1891-92.

TITLE.	No. of Sheets.	Scale.	REMARKS.
		Miles per inch.	
STANDARD MAPS.			
PUNJAB.			
District Hissar and Patiala State.			
Sheets Nos. 241 and 256	2	1	Fair maps and proofs examined, corrected and sent to press.
Districts Jullunder, Ludhiana, Hoshiarpur, and Umballa.			
Sheets Nos. 211, 212, 223, 224, 234, 235, 236, 237, 238, 248, 254, 255, 294 and 316	14	1	Proofs examined, press order given.
Sheets Nos. 239 and 240	2	1	Ditto ditto.
District Jhang.			
Sheets Nos. 116, 117, 142, 143 145, 168 and 169	7	1	Ditto ditto.
District Karnal and Sikh States.			
Sheets Nos. 271, 272, 273 and 274	4	1	Canals, village sites, and names inserted from the survey of 1889-90, and completed to margin for a second edition, and sent to press.
Bahawalpur State.			
Sheets Nos. 18 and 22	2	½	Fair maps corrected from new material for a second edition.
Indus Riverain Survey.			
Sheets Nos. 5 (S.E./1, 2, 3, 4); 6 (N.E./1, 2, 3, 4); 22 (N.W./1, 2, 3, 4), (S.E./1, 2, 3, 4), (S.W./4); 23 (N.W./1, 2, 3, 4), (N.E./1, 3), (S.W./1, 2, 3, 4); 24 (N.W./1, 3), and 45 (N.W./1, 3)	30	½	Fair maps examined and corrected.
NORTH-WESTERN PROVINCES AND OUDH.			
District Naini Tal.			
Portion of the late Tarai District.			
Sheet No. 63	1	1	Fair maps examined and sent to press.
Sheets Nos. 64, 65, 81 and 97	4	1	Fair maps examined and corrected.
Portion of the late Kumaun District.			
Sheets Nos. 46, 63, 250 and 251	4	1	Drawn, examined, and sent to press; proofs under examination.
Sheet No. 64	1	1	Drawn, examined, and held in abeyance for incorporation with recent survey of Rampur State.
Sheets Nos. 46 (N.E./2, 4), (S.E./2); 63 (N.W./1, 3, 4), (N.E./3), (S.W./1, 2, 3, 4), (S.E./1, 3, 4); 64 (N.E./1, 2, 3, 4), (S.E./2), 250 (S.W./3, and 251 (N.W./1, 2, 3, 4), (S.W./1, 2, 3, 4), (S.E./1, 3)	30	½	Fair maps examined and sent to press.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of Work.

TITLE.	Number of Sheets.	Scale.	REMARKS.
		Miles per inch.	
STANDARD MAPS—*contd.*			
NORTH-WESTERN PROVINCES AND OUDH—*contd.*			
District Bijnor.			
Sheets Nos. 2, 3, 4 and 6 . .	4	1	Fair maps corrected for a second edition.
District Bareilly.			
Sheets Nos. 1, 2, 3 and 4 . .	4	1	Ditto ditto.
Sheets Nos. 81, 82, 97 and 98 .	4	1	Printed sheets corrected for a second edition.
Districts Bahraich and Gonda.			
Sheets Nos. 160 and 161 . .	2	1	Proofs corrected and sent to press.
BENGAL.			
District Balasore.			
Sheets Nos. 2 and 4 (Pargana maps)	2	1	Printed sheets touched up; proofs passed and press order given.
Angul Estate (Orissa).			
Sheet No. 103	1	1	Fair maps and proofs examined and press order given.
Sheets Nos. 104, 105, 132, 133 and 134	5	1	Fair maps examined and proofs sent to press.
District Cuttack.			
Killa Kujang.			
Sheets Nos. 223, 224, 195 and 196	4	½	Fair maps examined and corrected.
District Dacca.			
Main Circuit Maps Nos. 9 and 10	2	1	Printed sheets touched up; proofs passed and press order given.
District Darjeeling.			
Sheets Nos. 269, 270, 271, 292, and 293.	5	½	Fair maps corrected to date for a second edition.
District Hooghly.			
Sheets Nos. 1 to 7 . . .	7	1	Ditto ditto ; proofs passed and press order given.
District Manbhum.			
Main Circuit Maps Nos. 16 and 19.	2	1	Printed sheets touched up for reproduction by photography; proofs passed and press order given.
District Mymensingh.			
Pargana maps Nos. 1, 8, 9 and 20.	4	1	Ditto ditto.
Sheets Nos. 343, 363, and 374 .	3	1	Proofs passed, press order given.
Sheet No. 375	1	1	Proofs examined and sent to press.
District Nadia.			
Pargana maps Nos. 1 to 8 .	8	1	Printed sheets touched up for reproduction by photography; proofs passed and press order given.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of Work.

Title.	Number of Sheets.	Scale.	Remarks.
STANDARD MAPS—*contd.*		Miles per inch.	
BENGAL—*continued.*			
District Pubna.			
Main Circuit maps Nos. 26 and 27.	1	1	Printed sheets touched up for reproduction by photography; proofs passed and press order given.
District 24-Parganas.			
Sheets Nos. 4, 5, and 6 . .	3	1	Ditto ditto.
District 24-Parganas.			
Dhee Punchanogram,			
Grand Division No. 1.			
Sub-divisions Nos. 1-2, $\frac{4}{1\text{-}2}$, 6-7-8, 15 and $\frac{18}{1, 2, 3}$.	11	99′	Printed sheets touched up for reproduction by photography; corrected to date and proofs examined.
Grand Division No. 2.			
Sub-divisions Nos. 6 and 14 .	2	99′	Ditto ditto.
Grand Division No. 3.			
Sub-divisions Nos. 2 (3, 4, 5, 6), 9, 11, $\frac{12}{1, 2, 3}$, 13, $\frac{15}{1, 2}$, 17, 18, 19, 20, 21, 22, and 23.	17	99′	Ditto ditto.
Grand Division No. 4.			
Sub-divisions Nos. $\frac{A}{1, 2}$, $\frac{B}{1, 2}$, E, F G, $\frac{H}{1, 2}$, and $\frac{I}{1, 2}$.	11	99′	Ditto ditto.
Grand Division No. 5.			
Sub-divisions Nos. $\frac{I}{2}$, $\frac{A}{1}$, $\frac{B. C. E}{1}$	3	99′	Ditto ditto.
Grand Division No. 6.			
Sub-divisions D. E. F. G., $\frac{J}{1, 2}$, K, $\frac{M.}{1, 2,}$ and N.	10	99′	Ditto ditto.
ASSAM.			
Districts Darrang and Kamrup.			
Sheets Nos. 25 and 38 . .	2	1	Completed to margin; proofs examined and press order given.
District Lakhimpur.			
Sheets Nos. 97, 98, 113, 114, 128, 129, 130, 138, 139, 140, 144, 145 and 146.	13	1	Fair maps corrected to date. Proofs examined and sent to press.
CENTRAL PROVINCES.			
District Chanda.			
Sheets Nos. 2 and 6 . .	2	1	Printed sheets touched up for reproduction by photography. Proofs passed, press order given.
BOMBAY.			
Sheets Nos. 179, 185, 244, 331, 352, 353 and 353A.	7	1	Proofs passed with press order.
Sheets Nos. 154, 186, 188, 274, 304 and 330.	6	$\frac{1}{2}$	Fair maps examined and sent to press.
Sheet No. 35 $\left(\frac{N. E.}{1, 2, 3, 4}\right)$		$\frac{1}{4}$	Fair maps touched up and proofs passed with press order.

DRAWING OFFICE, CALCUTTA

SECTION II.

Statement of Work.

TITLE.	Number of Sheets.	Scale.	REMARKS.
STANDARD MAPS—contd.		Miles per inch.	
BURMA.			
Sheets Nos. 181 and 227	2	1	Proofs passed and press order given.
Sheets Nos. 143, 144, 187, 188, 189, 190, 233, and 284.	8	½	Fair maps examined and proofs under examination.
Sheets Nos. 185, 186 and 232	3	½	Fair maps corrected to date for a second edition.
DISTRICT MAPS.			
Basti (N.-W. Provinces)	4	½	Proofs examined and press order given.
Gorakhpur „	4	½	Drawing well advanced.
Mirzapur „	5	½	Ditto in progress.
Garhwal „	4	½	Ditto ditto.
Raipur (Central Provinces)	6	½	Proofs examined and sent to press.
PLANS OF CITIES AND CANTONMENTS.			
City of Calcutta	2	1/6	Printed sheets corrected for a third edition.
Ditto ditto.	1	½	Proof passed with press order.
Peshawar Cantonment	4	½	Press order given.
Kamptee Cantonment	4	½	Proofs passed with press order.
City and Cantonment of Satara	1	1/6	Ditto ditto.
Map of Delhi showing the British position during the siege, 1857.	1	¼	Drawn; proofs under correction.
Map of Badli Sarai	1	1	Ditto ditto
Rangoon Town	19	1/16	Proofs passed with press order.
City and Cantonment of Dinapur	1	⅛	Ditto ditto.
Lucknow Cantonment	4	⅛	Fair maps corrected to date for a second edition.
Cawnpore ditto	4	1/16	Ditto ditto.
Benares ditto	4	1/16	Ditto ditto.
MISCELLANEOUS.			
Map of country between Aligarh and Meerut, cavalry camp of exercise	1	1	Proofs passed and press order given.
Specimen of Boundary symbols	1	1	Drawn; proof passed and press order given.
Sketch map to illustrate the marches of the Delhi Field Forces, 1857.	1	8	Drawn, examined, proofs under examination.
INDEX MAPS.			
For Annual Administration Report	11	...	Drawn and sent to press.
Ditto ditto	12	...	Corrected to date and sent to press.
PROOFS EXAMINED.			
Photozincographed maps	259	...	
Lithographed maps	12	...	
TRACINGS PREPARED.		...	
Tracings of sheets	61	...	
Ditto village plans	42		
MAPS COLOURED.			
Maps on various scales	168	...	For Surveyor-General's Office.

DRAWING OFFICE, CALCUTTA.

SECTION II.

Statement of Work.

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Hoshangabad, seasons 1887—89 . . .	
District Damoh „ 1885—87 . . .	
District Jhansi „ 1888—90 . . .	
Traverse data, etc., supplied.	
District Midnapore along district Balasore . .	For No. 8 Party.
District Puri along Chilka Lake	Ditto.
District Jubbulpore along district Mandla . .	For No. 9 Party.
District Goalpara along Garo Hills	For Deputy Commissioner, Kamrup.
Ditto ditto ditto	For Deputy Commissioner, Garo Hills.
Dakhin Shabazpur Villages	For No. 2 Party.
Village Traverses, supplied, 390 pages . . .	To public officers.
Field books of 5 villages, district Gorakhpur . .	To Sub-Assistant Conservator of Forests.
Area statement of villages in *pargana* Jalamuta .	For Burdwan Detachment.
Rectangular co-ordinates of triangulated stations in district Nimar	For No. 14 Party.
Values and description of level B. M. in and around Elephant Point, Rangoon	For No. 25 Party.
Values and description of level B. M. in district Bassein	To Executive Engineer.
Ditto ditto ditto Basti .	To Collector.
Miscellaneous.	
Calculated spherical co-ordinates of Revenue Survey stations in district Sibsagar, Delhi Cantonment, and part of district Dacca, plotted 1 village on 16-inch scale in district Hoshangabad; prepared a traverse circuit and plotted a group of villages of district Moorshedabad on 4-inch scale; also another group of villages in district Maldah; calculated areas by *parganas* of 2 sheets, Bengal; 17 sheets, Assam, 3 sheets, Punjab; and also areas of cantonments and residencies in Central India Agency. Prepared a statement showing measurement of local beegahs in use in district Sarun; also one of tri-junction *pucka* pillars in the districts of Oudh.	

DRAWING OFFICE, CALCUTTA.

SECTION III.—CADASTRAL.

State of publication of Cadastral Maps on the 30th September 1892.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS PREPARED			PUBLISHED				
	Up to 30th September 1891.	Added during past 12 months.	Total up to 30th September 1892.	Up to 30th September 1891.	By Surveyor General's Office during past 12 months.	Total to 30th September 1892.	Remaining to be published.	
North-Western Provinces.								
Agra	2,942	...	2,942	2,942	...	2,942	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,601(a)	...	1,601(b)	1,601	...	1,601	...	
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	5,571	...	5,571(b)	5,565	6	5,571	...	(a) Figures of previous return have been changed to agree with final results.
Benares	2,052	...	2,052(b)	2,052	...	2,052	...	
Bijnour	31	...	31	31	...	31	...	
Dehra Dun	701	...	701	701	...	701	...	
Fyzabad	14	...	14	14	...	14	...	
Ghazipur	4,021(a)	...	4,021(b)	4,021	...	4,021	...	
Gorakhpur	8,615(a)	...	8,615(b)	6,603	2,006	8,609	6	(b) These figures are liable to alteration until publication has been completed.
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,583(a)	...	3,583(b)	3,583	...	3,583	...	
Jhansi	...	1,149	1,149(b)	...	...	...	1,149	
Kumaun (Bhabar)	332(a)	...	332(b)	...	...	...	332	
Moradabad and Tarai	4,023	...	4,023	4,023	...	4,023	...	
Muttra	1,658	...	1,658	1,658	...	1,658	...	
Mirzapur	3,794(a)	...	3,794(b)	3,794	...	3,794	...	
Rampur State	...	1,349	1,349(b)	...	356	356	993	
Tarai	862	...	862(b)	409	187	596	266	
TOTAL	46,973	2,498	49,471	44,170	2,555	46,725	2,746	
Burma.								
Akyab	2,785	...	2,785	2,785	...	2,785	...	
Bassein	3,437	...	3,437	3,437	...	3,437	...	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Kyaukse	...	804	804(b	...	196	196	608	
Prome	847	...	847	847	...	847	...	
Tharrawaddy	1,363	...	1,363	1,363	...	1,363	392	
Thongwa	2,764	985	3,749(b)	2,020	1,337	3,357	...	
TOTAL	17,188	1,789	18,977	16,444	1,533	17,977	1,000	
Bengal.								
Patna and Gya	3,054	...	3,054	3,054	...	3,054	...	
Puri (Khorda Estate)	4,565	...	4,565	4,565	...	4,565	...	
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
Muzuffarpur	1	...	1	1	...	1	...	
TOTAL	12,544	...	12,544	12,544	...	12,544	...	
Assam.								
Darrang	718(a)	...	718	704	...	704	14	
Kamrup	1,675(a)	310	1,985	1,675	14	1,689	296	
Nowgong	753(a)	529	1,282	730	341	1,071	211	
Sibsagar	1,877(a)	...	1,877	1,037	454	1,491	386	
Sylhet	61	...	61	16	...	16	45	
TOTAL	5,084	839	5,923	4,162	809	4,971	952	
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
TOTAL	43	...	43	43	...	43	...	
GRAND TOTAL	81,832	5,126	86,958	77,363	4,897	82,260	4,698	

Abstract of Work performed during 1891-92.

PROVINCES.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof sheets examined previous to press order.	Coloured and subsequently examined.	
North-Western Provinces	2,097	364	2,562	2,555	Scale 16 inches = 1 mile.
Burma	1,195	456	1,587	1,533	Ditto ditto.
Bengal	...	...	...	...	Ditto ditto.
Assam	262	552	843	...	Ditto ditto.
TOTAL	3,554	1,372	4,992	4,088	

ENGRAVING OFFICE, CALCUTTA.

Statement showing the Work performed during the year 1891-92.

TITLE OF MAP.	Number of plates.	Outline, square inches.	Number of letters cut.	Hills, square inches.	REMARKS.
ENGRAVING.					
Atlas of India.					
Scale 1 inch = 4 miles.					
Quarter sheets (new) completed	4	15	4,982	92	
Ditto in progress	43	589	75,735	655	
Additions and corrections to published quarter sheets	34	63	10,989	114	
Additions and corrections to published full sheets	24	715	36,021	334	
New plates projected, etc.	1	...	...	...	
General Maps.					
On various scales	24	1,676	112,349	25	
rovincial Maps.					
On scale 1 inch = 16 miles	18	203	28,226	113	
On various scales for Administration Reports	3	...	2,762	...	
District Maps.					
On scale 1 inch = 4 miles	1	....	6,004	...	
On various scales for Administration Reports	31	411	21,287	97	
Index Maps	6	145	8,129	...	
Charts	2	4	1,139	...	
Miscellaneous subjects	17	...	12,904	1	
TOTAL	208	3,821	320,527	1,431	

COPPER PLATE PRINTING.

Impressions taken	18,049
Proofs pulled	492
Transfers pulled	426
TOTAL	18,967

STEEL FACING.

Double elephant plates steel-faced	37
Do. do. steel removed	43
Quarter sheets steel-faced	20
Do. steel removed	14
Miscellaneous plates steel-faced	27
Do. do. steel removed	17
TOTAL	158

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of COLONEL J. WATERHOUSE, S.C., *Assistant Surveyor-General, Season 1891-92.*

OUT-TURN.—The out-turn is still steadily increasing, and it is becoming very difficult for the office to meet the heavy demands upon it, especially for colour-printing work.

ORIGINAL SUBJECTS.—The total number of original subjects under reproduction during the year has been 7,532 ; of these 541 have been lithographed, and the remaining 6,905 reproduced by various photographic processes or by zincography. The increase on the whole is 465 subjects more than last year. Of the 541 subjects lithographed, only 63 were departmental, being one more than last year ; 478 were for other departments, or 122 less than last year. Of the 6,905 subjects reproduced by photography, 1,064 were departmental, 4,956 cadastral, and 885 were extra-departmental. Last year the numbers were 1,083 departmental, 4,376 cadastral, and 946 extra-departmental, showing differences of *minus* 19, *plus* 580 and *minus* 61 respectively.

From these figures it would appear that the number of subjects under reproduction has generally been less than last year, except in the case of the cadastral maps. The actual number of sheets of maps, etc., received during the year was 7,858 ; of which 1,071 were departmental, 4,934 cadastral, and 1,853 extra-departmental, and the numbers despatched were 7,490, of which 1,073 were departmental, 4,896 cadastral and 1,521 extra-departmental.

LITHOGRAPHIC DRAWING SECTION.—The total number of new drawings, or additions made to maps, etc., on stone, taken up and completed during the year was 577 ; of these 77 were departmental, and the remaining 500 for other departments. Last year 744 subjects were received, of which 101 were departmental and 643 extra-departmental. The section has remained under charge of Mr. H. L. Lepage, the Head Assistant. It is satisfactory to be able to report that in consideration of the increased work and responsibility of this post, the Government have sanctioned an increase to the maximum pay from ₹450 to ₹550.

Although the number of subjects for lithography has not increased, the work in this section has been very largely added to by the preparation of colour-stones, and the draftsmen have been fully occupied throughout the year.

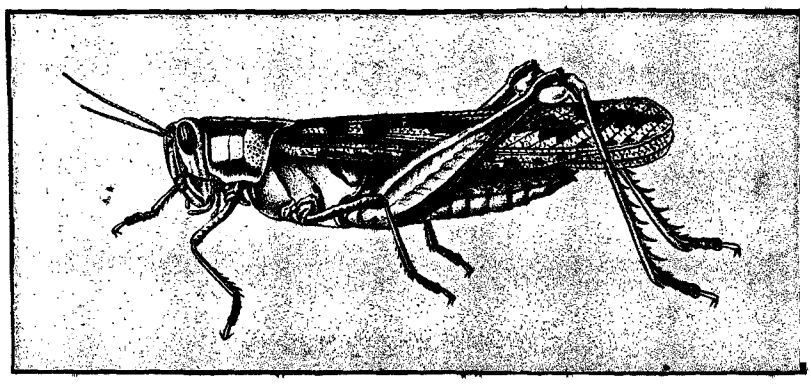
PHOTOGRAPHIC NEGATIVE SECTION.—The total number of negatives taken during the year was 6,153, including 106 negatives and transparencies for use in the heliogravure process. Of these, 1,440 were of departmental, 3,634 of cadastral, and 1,079 of extra-departmental maps, plans and drawings, as against 1,320 departmental, 3,211 cadastral, and 1,163 extra-departmental done during last year, showing a net increase of 459 negatives taken. The section has continued under charge of Mr. H. Haward, and there have been no changes in the processes. Mr. G. W. McKie was discharged on the 31st August for bringing in outside work to be reproduced in the office.

PHOTO-TRANSFER PRINTING SECTION.—The number of photo-transfer prints prepared was 5,729, of which 1,049 were of departmental, 3,648 of cadastral, and 1,032 of extra departmental subjects, as against 1,276 departmental, 3,257 cadastral, and 1,046 extra-departmental, showing a total increase of 150. The apparent falling off in departmental subjects is due to the fact that blue cyanotype prints are now largely used for proofs instead of photo-zincographs. The section has continued under charge of Mr. J. Harrold, and there have been no changes in the processes.

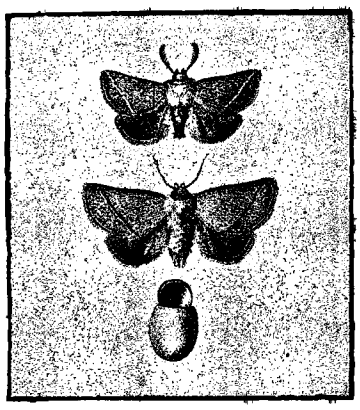
LITHOGRAPHIC AND ZINCOGRAPHIC PRINTING SECTIONS.—The work in these two sections has again very largely increased, and considerable difficulty has been found in getting through it with only one large lithographic machine. The demands for the ruled one-inch cadastral squares and meteorological charts take up a great part of the out-turn of one machine. The second quad-crown machine, referred to in last year's report, was received during the year and is now being put up. As soon as it is in working order, it is hoped that it will enable us to carry out the increasingly large requisitions for printing in colours which are now swamping us with only one large machine to meet them. In the lithographic printing section the number of subjects printed from stone was 541, or 140 less than last year ; of these, 63 were departmental and 478 extra-departmental, against 74 departmental and 607 extra-departmental of last year. The number of pulls was 426,655, or 142,836 more than last year, and of copies 348,153, against 329,027 of last year, the coloured copies being in excess by 18,354 over last year. From this it will be seen that although the number of subjects printed off was much less than last year, the actual work turned out was very considerably more, owing to so much of the work being done in colours.

In the Zinc Printing Section (normal), the number of plates printed was 942, of which 333 were departmental and 609 extra-departmental. The number of pulls was 179,434 (48,104 departmental and 131,330 extra-departmental), and of complete copies 254,285 (53,767 departmental and 200,518 extra-departmental). Last year, the number of plates printed was 1,127 (667 departmental and 460 extra-departmental) ; pulls 276,602 (111,485 departmental and 165,117 extra-departmental) and of complete copies 288,822 (108,724 departmental and 180,098 extra-departmental). This shows a considerable decrease in the number of plates printed of departmental subjects and a large increase in extra-departmental subjects, while the number of copies is 34,573 less. In the Zinc Printing Section (cadastral), 4,966 plates of cadastral maps of the North-Western Provinces, Burma and

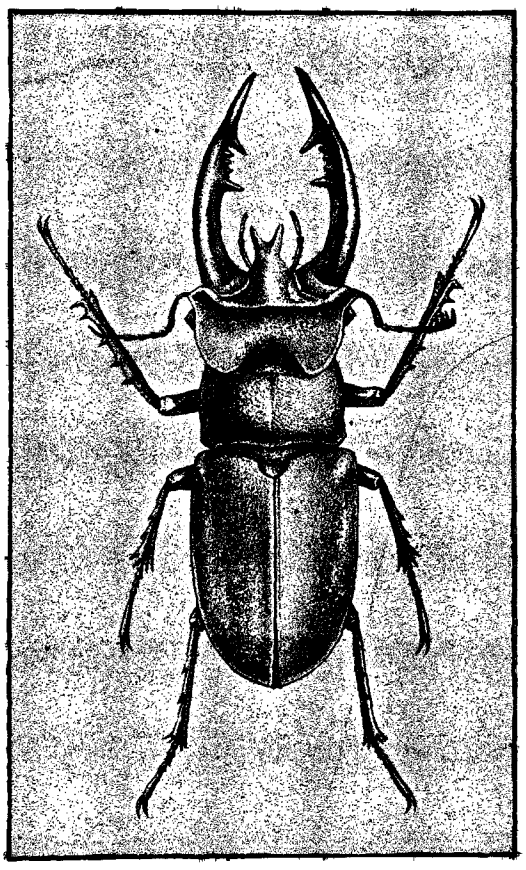
SPECIMENS OF PHOTO-BLOCK PRINTING. BITUMEN-GRAIN PROCESS.



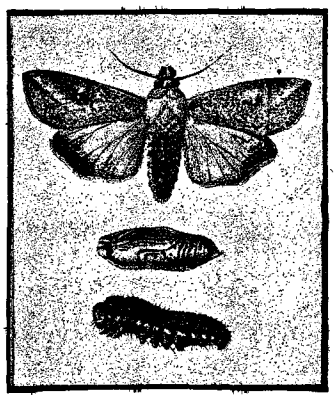
ACRIDIUM AERUGINOSUM: BURM.



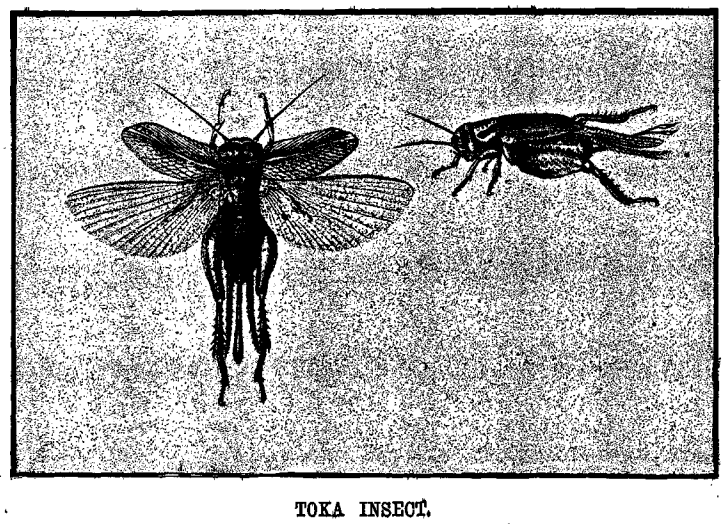
MIRESIA COTESI: SWINHOE.



LUCANUS LUNIFER: HOPE.



LEUCANIA EXTRANEA.



TOKA INSECT.

Reproduced, full scale, from Indian Ink Drawings.

S. I. O., Calcutta, January 1893.

Assam were printed off, the number of pulls being 149,979 and of copies of complete villages 139,819, as against 4,484 plates, 151,557 pulls and 142,519 complete copies of last year.

TYPE PRINTING SECTION.—The printed out-turn in this section again shows a large increase, although the number of items shows a decrease. The number of items set up was 8,615 as compared with 9,098 of last year, the number of pulls being 1,318,597 and of copies 678,968 against 1,074,280 and 581,690 of last year. The printing work has now nearly reached its limit and is in advance of the composing. If the work increases, it will be necessary to set up another steam machine to clear it off. The section has continued under Mr. De Pyvah.

SILVER PRINTING SECTION.—The silver printing shows a large increase, principally on account of silver prints produced for the Secretary of State for India of the photographs to illustrate the late Dr. Forchhammer's reports on the antiquities of Arakan and Pagan, the number of prints being 2,998 against 1,105 of the previous year. The section has also been well employed in producing blue prints for proofs, the number amounting to 2,466 against 2 691 of the previous year.

HELIOGRAVURE SECTION.—This section has remained under charge of Mr. A. W. Turner throughout the year and has made good progress; 50 plates have been prepared by the photo-etching process, and 42, 415 copies printed showing a decrease of 20 in the number of plates and an increase of 8,400 in the number of copies as compared with last year. The decrease in the number of plates prepared is explained by the fact that most of the drawings of insects illustrating Mr. Cotes' papers on Economic Entomology are now reproduced by the block process instead of by heliogravure ; 57 blocks were produced during the year, or 22 more than last year.

Photo-etching Process.—No changes have been made in the methods of preparing or etching the engraved plates. For printing, the cold ink noticed in last year's report has been found to answer perfectly and has many advantages over the ordinary method of inking with heat, notably the saving of gas, or other fuel, and the unnecessary heating of the work-rooms, while at the same time the impressions are better, owing to the finer grinding of the colour. We have prepared the inks for ourselves from the formulæ given me at the Ordnance Survey Office, Southampton, last year, but some trial inks obtained from Messrs. Winstone & Co., and Shackell and Edwards gave good results.

The most noteworthy work of the year has been the reproduction of the birch-bark manuscripts discovered in Western Turkestan by Lieutenant Bower. The leaves of the manuscripts had all a more or less yellow tinge, and some of them were very dark and discoloured by age, so that in parts the writing was barely legible. Some of the leaves were reproduced upon plates prepared with the orthochromatic collodio-bromide emulsion described below, and others on gelatine plates rendered orthochromatic by being treated with a tincture containing erythrosin, silver nitrate and ammonium picrate. By this means very successful results have been obtained, as the specimen at page 99 will show.

It may be worth recording here that it has been found that after about 1,000 impressions, plates with delicate shading in the lights may lose much of it and the plate be apparently worn out. This is due to the polishing of the steel-faced surface from the constant rubbing of the hand in printing, but if the steel-facing be removed and renewed, the plate can be printed again in all its original perfection. The D copper-plate printing machine, noticed at page lxvi of the appendix of the last Annual Report, was received and set up. It was found to work more rapidly than the ordinary hand presses, but the very heavy pressure caused by the plates coming suddenly under the cylinder was liable to stop the machine and made it difficult to work. Moreover, the stoppage of the printing of the plates for the "*Indian Museum Notes*" from photo-etched plates has greatly decreased the copper-plate printing, and what remains can easily be dealt with by the ordinary staff in the hand-presses. The machine will be valuable should greater pressure of work come on again.

Photo-Block Processes, Bitumen grain method.—This method is an application of the photo-etching process, as ordinarily worked, to the production of a raised printing surface for typographic block printing instead of an incised surface for copper-plate printing. It is worked much in the same manner as described in the Annual Report for 1886-87, but the further experience gained in working these processes has led to the introduction of improvements which bring out the real value of the method for producing delicate blockwork. It is simple and quick. No special negative is required, and the blocks are found to print in the Caxton platen machine without difficulty or special treatment. A great advantage of this process is the rapidity with which the printing can be carried on, at the rate of 1,500 to 2,000 a day, instead of about 80 to 100 as with heliogravure plates. Specimens of the results obtained are annexed.

Several photo-blocks were also prepared by means of the ruled glass screens and by the method described in last year's Annual Report, in which pigment tissue is used for forming the image on copper instead of asphalt or bichromated albumen on zinc or copper.

Some attention has been paid to the best method of obtaining the desired results in making negatives by means of these screens, and it has been found that the nature of the grain is affected, first, by the volume of light passing through the lens, and this depends very much upon the subject to be copied, be it a light or dark one ; by the aperture of the lens used, and by the light in the studio in which the work is done. Secondly, by the

distance between the screen and the sensitive plate. Consequently each subject requires a certain adjustment of the diaphragms of the lens and of the distance between the screen and the plate which can only be learned by practice.

Nine blocks of figures of soldiers to illustrate the musketry regulations and thirteen to illustrate the "*Indian Museum Notes*," besides other experimental ones, were prepared by this method.

Electrotyping.—The electrotyping work shows a falling off, only 14 plates having been reproduced in this manner against 26 of last year, but they have been larger in size. The out-turn in this section depends entirely upon the wants of the Engraving Office. During the year an attempt was made to adopt vertical depositing troughs instead of horizontal ones, with the object of saving space with the large cells required to deposit double elephant plates, and also to economise time by depositing two plates in one cell instead of one. A trial on the small scale gave excellent results, and a large cell was therefore made up on the same principle; but the result was a complete failure, the deposited copper being very brittle and adherent to the matrix. There was also a great waste of copper by deposition in the inner cell, and it has therefore been thought better to continue working in the old way. These vertical batteries consisted of a central porous cell made with leather sides in which the iron plate and dilute sulphuric acid were placed, while the outer cell contained the solution of sulphate of copper and two depositing plates, one on each side of the central cell.

EXPERIMENTAL AND PERSONAL WORK.—Soon after my return from furlough in November 1891, I had to go again very fully into the question of the reorganisation of the offices and to revise my proposals, which took up most of my spare time till June. In July my health failed, and I was more or less unwell till October. This and the heavier pressure of ordinary office work have prevented my doing very much experimental work or carrying to completion investigations noticed in previous reports. The most important work I have been engaged upon was a trial of an orthochromatic collodio-bromide emulsion process published by Dr. A. Jonas of Vienna, based on Dr. E. Albert's method noticed in last year's report. The process has been found to work very well for half tone work. The plates are almost as sensitive as the slower kinds of gelatine dry plates It is in its present form not so well adapted for line work, but further trials to adopt the process into a dry plate one for general use in copying work in the office were stopped by my ill-health some months ago, and I have not yet been able to resume them. The following is a brief outline of the operations:—

Dr. Jonas' process of preparing the emulsion is based on the silver and ammonia method of preparing the silver bromide gelatine emulsions, but he overcomes the deleterious action which the free ammonia would have on the collodion by neutralising it with acetic acid and thus obtains an emulsion which is exceedingly fine in the grain and creamy.

SOLUTION I.

Ammonium bromide	64 grammes.
Distilled water	80 c. c.
Absolute alcohol	800 „
Thick collodion (4%)	1,500 „
Glacial acetic acid	65 „

The ammonium bromide is first dissolved in the water with heat, then the alcohol, collodion and acetic acid are added in order.

For the collodion I used a mixture of 4 per cent. solutions of Schering's celloidin and of Morson's pyroxyline, both in equal parts of ether and alcohol, the same as ordinarily made up for use in the office, but thicker.

SOLUTION II.

Crystallised nitrate of silver	80 grammes.
Distilled water	50 c. c.

The silver salt is dissolved in the water with heat, and then strong solution of ammonia is added in small portions till the precipitate is redissolved (this takes about 75 c. c.); 800 c. c. of alcohol warmed to 113° are then added. This solution should remain clear and colourless. If it turns brown the alcohol is impure. Both solutions I and II can be prepared in day-light.

Solution II is poured in a thin stream into Solution I, the latter being well shaken meanwhile. This must be done in a dark room with an orange light. Solution II must be kept heated from about 103° to 122° F., otherwise the silver-ammonia salt will crystalise out. It is desirable, therefore, to stand the solution from time to time in a water bath. The mixing of the above quantity of emulsion should take about 10 minutes. The mixed emulsion is well shaken up and tested for acidity. A little of it being poured on a glass slip and wetted with water should show a slightly acid reaction. If alkaline, it is acidified by adding acetic acid drop by drop. It is then well shaken for about a quarter of an hour, and after standing for an hour may either be washed at once by pouring it into five or six times its volume of water, or be kept for one, two, or at most three, days to ripen before washing. This I found to be an advantage in giving greater sensitiveness. The washing

water may be changed once or twice, and the silver bromide collodion being separated out is collected in a funnel on a clean linen cloth, the ends of the latter being fastened so as to form a bag, and is washed in running water under the tap for about two hours. It is then finally washed with distilled water and after wringing to get the moisture out it is spread out on the cloth placed over a clean glass plate and allowed to dry. The dry silver bromide collodion can then be collected and kept in black bottles in a dark place for use as required.

To make the final emulsion dissolve—

Silver bromide collodion	6	grammes.
Alcohol	40	c. c.
Ether	60	c. c.

The mixed washed emulsion can be kept ready for use and keeps well in closely stoppered bottles.

I found that the emulsion could also be used unwashed with good results. At first it gave rather dense pictures with very clear shadows and would then be very good for copying line-work, but after a few days it became more sensitive and the image less dense and hard; the film also became more uniform in texture. After a week it was very sensitive, but began to give foggy images. The unwashed emulsion would probably work well if used within three or four days of being made up and would of course be much more economical for work on the large scale. The only inconvenience would be that the emulsion would have to be mixed daily.

In his paper in the *Photographisches Correspondenz* for July 1891, Dr. Jonas has entered very fully into the preparation of the eosin and other solutions for colouring the emulsion. I found, however, that it was better not to colour the emulsion itself, as the coloured emulsion will not keep in good order beyond a day, but to use the emulsion in its plain state and colour the films with a colouring and sensitising bath made of—

Erythrosin	1	gramme.
Silver nitrate	1	„
Picric acid	1	„
Ammonia (s. g. 880) about	30	c. c.
Spirit of wine	500	„
Water	500	„

The glass plates are well cleaned and prepared with an edging of gelatine solution made as follows:—

Gelatine	5	grammes.
Distilled water	500	c. c.

When dissolved add—

Glacial acetic acid	15	c. c.
Alcohol	15	„ „

This is applied round the edges of the plate, for about ¼ inch, with a feather and allowed to dry.

The plates are then coated with the emulsion, either washed or unwashed, and when the collodion is well set, are washed under the tap till all greasiness is removed and flowed with the erythrosin and picrate tincture given above, and after draining a little, are ready for exposure.

The exposure is about one-third of what would be given with a wet collodion plate, and as the picrate of ammonia not only adds very greatly to the sensitiveness of the plate to the yellow and yellow-green rays and at the same time tints the film yellow, no yellow screen is necessary in copying paintings, etc. It was found that practically the plates coated with ripened washed emulsion and coloured as above were about as sensitive as Wratten's "ordinary" plates.

The light used for the coating and development of these plates must be red or such as is suitable for the most sensitive gelatine plates; yellow light will not answer.

The coloured emulsion plates are most sensitive when exposed in a moist state; if allowed to dry they become insensitive and give foggy pictures.

For developing these plates hydroquinone or para-amidophenol hydrochlorate answer well and the following formulæ have given good results:—

Hydroquinone	1	part.
Sodium sulphite	4	„
Lithia carbonate	1	„
Potassium bromide	5	„
Water	100	„

Para-amidophenol hydrochlorate	1	part.
Sodium sulphite	5	„
„ carbonate (Anhydrous)	4	„
Water	200	„

This developer gives great density and clearness and may be used over and over again till exhausted. It is best prepared by first dissolving the para-amidophenol in the water, then the sulphite, and finally adding the carbonate. In this way the formation of a precipitate is avoided, but if any should form it can be redissolved by heat.

The plates can be intensified before or after fixing with any of the ordinary acid pyro-silver or hydroquinone silver intensifying solutions, or, if extra density is required, by the copper bromide or mercurial processes.

The whole virtue of the process lies in the colouring tincture of erythrosin-silver and ammonium picrate. Whereas a coloured plate will, with a certain exposure and development, give a rich and fully detailed image, an uncoloured plate under the same conditions will give only the ghost of an image. The same tincture, when diluted to 1: 10,000, forms a very good orthochromatising bath for gelatine dry plates and has been usefully employed in copying the dark yellow birch-bark leaves of the Bower manuscript.

For copying line work the emulsion seems to require some modification in order to secure quite clear, sharp lines. In copying with the finely ruled screens for photo-block work, considerable difficulty was found in getting sharpness with the coloured films, although wet collodion plates under the same conditions gave quite a sharp image. As it appeared likely that the highly coloured moist film might disturb the achromatism of the lens in the same way as a coloured glass screen would do, trials were made of other sensitisers for the collodio-bromide film, *viz.*, berberin, annatto, and quercitrin. A solution of quercitrin at 1: 1,000, without ammonia, flowed over the plates coated with the washed emulsion, gave about the same sensibility as wet collodion, the plates being exposed moist The resulting images, though fairly good, do not show the richness and vigour of those done with the orthochromatic tincture.

Trials were also made of similar preservatives in preparing dry plates with the emulsion. The quercitrin solution with a little gelatine or gum gave good plates, but perhaps the most promising results were obtained with a preservative made of—

Gum and sugar solution (Carey Lea's)	. . . . .	7	c. c.
Tincture of Jaborandi	. . . . .	7	" "
Water	. . . . .	15	" "

A mixture of laudanum and water in equal parts also gave good results. These dry plate trials were unfortunately stopped by ill-health, and I have not yet had an opportunity of resuming them.

If a good method could be found of preparing dry plates with an unwashed emulsion of this kind, even if only of equal sensitiveness with wet plates, they would probably be found very convenient for use in the office and might be more economical than the ordinary wet process still in use.

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Specification.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies.		
								Coloured.	Uncoloured.	Total.
Departmental Maps and Plans.										
General Maps	22	4	20	4	14	7	4,309	500	1,409	1,909
Provincial Maps	32	29	29	12	7	11	1,448	...	724	724
Divisional Maps	...	...	...	...	4	...	450	...	450	450
District Maps	10	4	4	1	3	3	625	...	900	900
Plans of Cities and Cantonments	60	143	130	60	30	...	2,850	...	2,850	2,850
Standard Maps	430	564	387	131	162	20	23,406	...	23,556	23,556
Index Maps	46	40	25	31	32	7	14,615	12,300	2,540	14,840
Technical Charts	9	25	20	4	4	...	209	...	250	250
Miscellaneous Maps and Plans	533	631	434	132	77	19	18,119	1,909	19,212	21,121
Transfers and Proofs	...	...	...	...	...	...	2,865	...	...	...
Departmental Forms	10	...	...	...	...	15	61,357	...	58,145	58,145
Type Printing	...	...	...	...	...	...	...	...	...	...
Total (Normal)	1,152	1,440	1,049	375	333	82	130,244	14,709	110,036	124,745
Cadastral Maps.										
North-Western Provinces and Oudh—										
Photo-zincographs	2,113	2,113	2,178	2,209	2,209	...	35,608	...	35,608	35,608
Zincographs	351	...	...	351	351	...	6,387	...	6,387	6,387
Total	2,464	2,113	2,178	2,560	2,560	...	41,995	...	41,995	41,995
Burma—										
Photo-zincographs	1,238	1,238	1,186	1,079	1,079	...	36,712	...	36,712	36,712
Zincographs	477	...	...	477	477	...	16,062	...	16,062	16,062
Total	1,715	1,238	1,186	1,556	1,556	...	52,774	...	52,774	52,774
Assam—										
Photo-zincographs	283	283	284	356	356	...	18,868	...	18,868	18,868
Zincographs	494	...	...	494	494	...	26,182	...	26,182	26,182
Total	777	283	284	850	850	...	45,050	...	45,050	45,050
Transfers and Proofs	...	...	...	...	...	...	10,160	...	...	...
Total (Cadastral)	4,956	3,634	3,648	4,966	4,966	...	149,979	...	139,819	139,819
Grand Total (Normal and Cadastral)	6,108	5,074	4,697	5,341	5,299	82	280,223	14,709	249,855	264,564

LITHOGRAPHIC OFFICE.

done during the year 1891-92.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo. Blocks.	Electrotypes.		
										₹ a. p.	
...	...	...	... 4	4	...	...	...	...	...	2,413 15 3	Six subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	985 4 6	Two ditto ditto.
...	...	...	...	...	...	...	...	...	...	154 8 3	
...	...	...	...	27	...	...	...	...	...	2,567 13 6	Six subjects not yet printed.
...	...	...	...	1,312	...	...	...	...	...	2,956 6 6	
...	...	...	...	132	...	...	...	...	...	20,778 15 3	Nine subjects not yet printed.
...	...	...	...	30	...	...	...	...	...	1,205 9 6	
...	...	...	411	852	...	9	1,517	5	14	382 3 6	
...	...	...	...	...	...	...	...	...	...	13,638 13 3	Two subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	...	
8,615	1,318,597	678,968	...	...	...	...	...	...	...	8,296 3 0	
										15,819 3 9	
8,615	1,318,597	678,968	415	2,357	...	9	1,517	5	14	69,199 0 3	
...	...	...	...	...	...	...	...	...	...	30,687 4 9	
...	...	...	...	...	...	...	...	...	...	2,743 5 6	
...	...	...	...	...	...	...	...	...	...	33,430 10 3	
...	...	...	...	...	...	...	...	...	...	17,879 15 0	
...	...	...	...	...	...	...	...	...	...	4,293 0 0	
...	...	...	...	...	...	...	...	...	...	22,172 15 0	
...	...	...	...	...	...	...	...	...	...	6,616 0 6	
...	...	...	...	...	...	...	...	...	...	6,260 4 0	
...	...	...	...	...	...	...	...	...	...	12,876 4 6	
...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	68,479 13 9	
8,615	1,318,597	678,968	415	2,357	...	9	1,517	5	14	137,678 14 0	

Statement of work done for other

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of Copies.		
								Coloured.	Uncoloured.	Total.
Adjutant General in India	21	6	2	12	12	2	5,952	...	8,876	8,876
Administrative Medical Officer, Presidency District	2	2	...	...	...	...	...	...	...	...
Agent to the Governor-General, Central India	1	...	...	...	...	4	4,000	1,000	...	1,000
Archæological Survey, N.-W. Provinces and Oudh	...	...	...	...	...	...	...	...	...	...
Asiatic Society of Bengal	5	2	...	...	...	1	680	...	680	680
Bengal Dooars Railway	10	10	10	3	3	...	150	...	500	500
Board of Revenue, Bengal	9	...	...	18	18	15	11,020	6,460	820	7,280
,, ,, N.-W. Provinces	1	1	11	3	7	...	1,400	...	1,400	1,400
Calcutta Municipality	3	3	2	2	1	...	200	...	400	400
Chief Commissioner, Assam	...	...	...	1	1	...	1,500	...	3,000	3,000
,, ,, Burma	2	...	...	...	...	1	125	...	125	125
,, Engineer, Bengal, Public Works Department	21	40	40	18	19	5	4,750	1,050	3,590	4,640
,, ,, Irrigation Works, Punjab	13	14	14	14	11	3	4,140	410	4,860	5,270
,, ,, Bombay, Baroda and C. I. Railway	1	2	2	2	2	...	100	...	100	100
Commissioner of Ajmere	2	1	1	1	1	...	50	...	100	100
,, of Chota Nagpur	...	...	...	4	6	...	3,560	3,560	...	3,560
,, of Excise, Bengal	6	...	...	...	...	6	2,280	2,280	...	2,280
,, ,, Punjab	8	...	...	...	...	12	2,580	1,720	...	1,720
,, Hyderabad Assigned Districts	...	...	...	...	1	...	260	...	430	430
,, of Police, Calcutta	1	...	...	...	...	2	2,090	1,045	...	1,045
,, of Salt, Abkari, etc., Madras	1	...	...	...	...	1	405	...	405	405
,, of Settlement and Agriculture, Centl. Provs.	1	...	...	...	...	2	2,168	...	4,010	4,010
Commissary General-in-Chief	15	3	...	...	...	6	7,500	...	11,250	11,250
Consulting Engr. to Government of India for Railways	3	26	26	8	8	...	696	150	396	546
Controller of Stores, East Indian Railway	...	...	...	2	2	...	400	...	1,600	1,600
Curator, Provincial Museum, Lucknow	...	...	...	...	...	...	...	...	...	...
Deputy Commissioner, Mandalay	55	100	100	45	110	...	4,745	...	5,245	5,245
,, Assistant Adjutant General, Lahore District	2	4	4	2	2	...	100	...	100	100
,, ,, ,, ,, Oudh District	1	2	2	1	1	...	200	...	200	200
,, ,, ,, ,, Rohilkhund District	1	4	4	1	1	...	30	...	30	30
Deputy Post Master General, Sind and Baluchistan	...	...	...	...	...	...	10	...	10	10
Director General of Military Works	71	92	93	30	30	...	7,130	...	14,020	14,020
,, ,, of Post Office	2	...	...	...	...	2	150	...	150	150
,, ,, of Railways	193	167	175	93	75	31	36,284	2,320	51,057	53,337
,, ,, of Telegraphs	23	2	3	1	2	17	9,119	30	10,232	10,262
,, ,, of Ordnance	1	...	...	...	...	...	...	...	...	...
,, Geological Survey of India	11	8	4	2	2	2	3,480	...	3,480	3,480
,, Persian Gulf Telegraphs	...	...	...	...	...	1	960	...	480	480
,, of Land Records and Agriculture, Assam	1	2	2	1	2	...	200	...	200	200
,, ,, ,, ,, ,, Bengal	3	...	10	1	...	5	1,650	200	1,050	1,250
,, ,, ,, ,, ,, Burma	1	...	...	...	...	1	3,400	...	3,400	3,400
,, ,, ,, ,, ,, Punjab	2	4	8	2	2	...	200	...	200	200
,, ,, ,, ,, ,, Gwalior State	...	...	...	...	...	1	1,000	...	1,000	1,000
,, of Military Education in India	7	1	1	1	1	11	5,700	2,900	300	3,200
,, of Public Instruction, Bengal	4	...	...	...	...	4	9,360	2,340	...	2,340
,, of Settlement and Revenue Records, Punjab	1	4	4	1	1	...	100	...	100	100
Engineer-in-Chief, East Coast Railway	22	22	22	7	11	...	970	...	2,580	2,580
Executive Engineer, Nagpur Division	...	...	...	...	14	...	217	...	217	217
Financial Commissioner, Burma	3	4	2	1	1	...	60	...	60	60
,, ,, Punjab	3	...	...	...	...	4	920	235	450	685
General Officer Commanding Hyderabad Contingent	1	...	...	...	...	2	100	...	50	50
,, ,, ,, Meerut Division	1	2	2	1	1	...	50	...	50	50
,, ,, ,, Secunderabad District	1	4	4	1	1	...	360	...	360	360
,, Supdt., Horse-Breeding Operations in India	6	...	...	...	...	5	680	160	500	660
Government of India, Rev. and Agri. Department	167	44	2	1	...	15	9,875	1,500	3,675	5,175
,, ,, Foreign Department	53	52	52	20	23	19	9,061	...	10,883	10,883
,, ,, Home Department	3	1	1	1	1	2	202	...	202	202
,, ,, Marine Department	6	10	...	...	...	...	...	...	...	...
,, ,, Military Department	8	5	5	7	8	1	536	...	949	949
,, ,, Public Works Department	27	23	19	8	6	9	6,990	1,860	3,350	5,210
,, Bengal, Revenue and General Department	16	9	9	6	7	4	34,299	18,882	597	19,479
,, ,, Financial Department	13	8	7	3	...	...	...	...	...	...
,, ,, Judicial and Political Department	5	...	...	...	2	3	1,012	...	2,086	2,086
,, ,, Marine Department	7	6	6	2	3	1	620	...	880	880
,, ,, Public Works Department	3	10	10	4	4	3	2,390	1,460	200	1,660
,, ,, Municipal Department	1	...	...	...	...	3	2,106	702	...	702
,, ,, Statistical Department	...	...	...	...	1	...	160	...	160	160
Government, N.-W. P. and Oudh, Public Works Dept.	68	61	61	28	12	23	10,480	1,000	7,720	8,720
,, of Punjab, Public Works Department	41	41	41	29	50	23	11,770	1,210	13,250	14,416
,, of Madras	...	...	...	...	...	...	...	...	...	...
,, Epigraphist, Madras	7	6	4	2	2	...	1,310	...	1,965	1,965
,, Straits Settlement	...	...	...	...	...	1	200	...	200	200
Indian Antiquary, Bombay	1	1	2	1	...	...	...	...	...	...
,, Museum	12	18	...	...	...	...	...	...	...	...
Inspector General of Artillery	1	...	...	...	...	1	76	...	76	76
,, of Civil Hospitals, Bengal	1	...	...	...	...	2	225	...	225	225
,, of Ordnance	4	3	3	4	...	...	...	...	...	...
,, of Police, Calcutta	6	...	...	1	...	7	2,585	2,270	...	2,270
Leprosy Commissioners	20	...	8	4	5	35	29,120	10,264	3,882	14,146
Manager, Burma State Railway	2	1	1	...	...	...	...	...	...	...
,, Warora Coal Field	1	1	1	1	1	...	50	...	50	50
Meteorological Reporter to the Government of India	147	23	23	...	1	67	57,945	24,070	55,085	79,155
Carried over	1,162	855	803	400	475	365	324,693	89,078	243,498	332,576

LITHOGRAPHIC OFFICE.

Departments, etc., during the year 1891-92.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.			Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plate.	Heliogravure prints.	Photo-blocks.	Electrotypes.	£	a.	p.	
...	...	...	48	20	...	...	...	...	...	1,370	2	0	Eight subjects not yet printed.
...	...	...	...	...	...	...	...	2	...	57	9	9	
...	...	...	8	...	...	...	...	...	...	135	7	0	
...	...	...	...	...	...	...	...	...	...	6	0	0	
...	...	...	...	...	...	...	...	...	...	40	9	6	
...	...	...	...	...	...	...	...	...	...	169	8	6	
...	...	...	...	...	...	...	...	...	...	788	1	9	
...	...	...	...	...	...	...	...	...	...	456	5	9	
...	...	...	...	1	...	...	...	...	...	70	5	0	
...	...	...	...	...	...	...	...	...	...	59	11	3	
...	...	...	...	...	...	...	...	...	...	115	6	0	One subject not yet printed.
...	...	...	...	...	...	...	...	...	...	1,342	7	9	
...	...	...	...	...	...	...	...	...	...	678	13	0	
...	...	...	...	...	...	...	...	...	...	52	14	3	
...	...	...	...	...	...	...	...	...	...	20	15	9	
...	...	...	...	...	...	...	...	...	...	156	5	9	
...	...	...	...	...	...	...	...	...	...	251	5	0	
...	...	...	...	...	...	...	...	...	...	199	0	0	
...	...	...	...	...	...	...	...	...	...	13	12	0	
...	...	...	...	...	...	...	...	...	...	128	13	0	
...	...	...	...	...	...	...	...	...	...	127	2	0	
...	...	...	...	...	...	...	...	...	...	356	11	0	
...	...	...	...	3	...	...	...	...	...	368	4	3	
...	...	...	...	...	...	...	...	...	...	411	2	6	
...	...	...	...	...	...	...	...	...	...	92	4	0	
...	...	...	161	...	...	...	...	...	...	109	15	3	
...	...	...	...	...	...	...	...	...	...	2,611	6	6	
...	...	...	...	...	...	...	...	...	...	71	1	6	
...	...	...	...	...	...	...	...	...	...	69	3	0	
...	...	...	...	...	...	...	...	...	...	52	12	9	
...	...	...	...	...	...	...	...	...	...	7	12	0	
...	...	...	...	...	...	...	...	...	...	2,269	0	0	
...	...	...	...	...	...	...	...	...	...	220	2	0	
...	...	...	...	4	...	...	...	...	...	7,006	8	0	Thirteen subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	756	7	3	
...	...	...	...	...	...	...	...	...	...	12	0	0	
...	...	...	...	4	...	1	527	3	...	980	3	3	One subject not yet printed.
...	...	...	...	...	...	...	...	...	...	28	1	0	
...	...	...	...	...	...	...	...	...	...	77	1	9	
...	...	...	...	...	...	...	...	...	...	156	2	3	
...	...	...	...	...	...	...	...	...	...	1,176	8	0	
...	...	...	...	...	...	...	...	...	...	139	12	3	
...	...	...	...	...	...	...	...	...	...	160	1	0	
...	...	...	...	...	...	...	...	...	...	553	11	9	
...	...	...	...	...	...	...	...	...	...	122	7	0	
...	...	...	...	...	...	...	...	...	...	82	6	6	
...	...	...	...	...	...	...	...	...	...	445	1	6	
...	...	...	...	...	...	...	...	...	...	99	15	9	
...	...	...	...	...	...	2	304	...	...	174	3	3	
...	...	...	...	...	...	...	...	...	...	375	12	0	
...	...	...	...	...	...	...	...	...	...	75	0	0	
...	...	...	...	...	...	...	...	...	...	41	1	6	
...	...	...	...	...	...	...	...	...	...	134	10	0	
...	...	...	...	...	...	...	...	...	...	101	1	0	
...	...	...	94	7	...	18	32,376	35	...	6,545	15	6	
...	...	...	...	...	...	...	...	...	...	3,057	14	9	One subject not yet printed.
...	...	...	...	...	...	...	...	...	...	96	5	6	
...	...	...	...	...	...	5	1,758	...	...	616	15	3	
...	...	...	...	...	...	...	...	...	...	132	9	6	
...	...	...	12	...	...	6	6	...	...	3,078	8	3	
...	...	...	...	...	...	...	...	...	...	1,774	5	3	Six subjects not yet printed.
...	...	...	...	2	...	...	...	...	...	151	7	6	Two ditto ditto.
...	...	...	...	...	...	...	...	...	...	372	14	9	
...	...	...	...	...	...	...	...	...	...	261	11	9	Three subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	324	4	9	
...	...	...	...	...	...	...	...	...	...	73	1	0	
...	...	...	...	...	...	...	...	...	...	17	12	9	
...	...	...	...	30	...	...	...	...	...	5,203	15	3	
...	...	...	...	...	...	...	655	...	...	3,755	5	6	
...	...	...	...	...	...	...	...	...	...	105	0	0	
...	...	...	...	...	...	1	2	...	...	257	14	3	
...	...	...	...	...	...	...	...	...	...	38	6	0	
...	...	...	...	...	...	...	...	...	...	18	0	0	
...	...	...	45	4	...	7	1,259	...	...	734	6	3	
...	...	...	...	...	...	...	...	...	...	43	3	0	
...	...	...	...	...	...	...	...	...	...	89	4	0	
...	...	...	...	...	...	...	...	...	...	89	6	0	
...	...	...	...	...	...	...	...	...	...	264	13	9	
...	...	...	...	...	...	...	...	...	...	1,299	8	0	Two subjects not yet printed.
...	...	...	...	...	...	...	...	...	...	54	0	0	One ditto ditto.
...	...	...	...	...	...	...	...	...	...	26	3	3	
...	...	...	...	...	...	...	...	...	...	3,204	6	9	Six subjects not yet printed.
...	...	...	368	75	...	40	36,887	40	...	57,326	0	3	

Statement of work done for other

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred	Zinc plates printed.	Stones.	Pulls.	Number of copies.		
								Coloured.	Uncoloured.	Total.
Brought forward	1,162	855	803	400	475	36	324,693	89,078	243,498	332,576
Meteorological Reporter to the Government of Bengal	4	...	...	...	...		31,524	16	31,500	31,516
Natural History Society, Bombay	...	...	...	...	...	...	...	...	...	...
Officer Commanding Allahabad District	1	4		1	...	...	...	...	...	...
" " 1st Battalion, East Surrey Regiment	1	1	4	1		1	100	...	100	100
" " Punjab Frontier Force	1	2	2	1		1	90	...	90	90
" " Quetta District	1	4	4	1		1	100	...	100	100
" in charge Census Operations, Rajputana	5	...	...	...	...		4,070	2,020	30	2,050
" " Lower Burma Field to Field Survey	1	...	...	...	...	1	3,200	...	3,200	3,200
Ordnance Officer Fort William	...	...	...	...	...	...	...	...	...	...
Photographic Society of India	5	6	...	...	...	...	...	...	...	...
Political Agent, Chhatisgarh Feudatories	...	...	...	...	...	1	200	...	200	200
" Manipur	...	...	2	1	1	...	150	...	150	150
Port Commissioners, Calcutta	1	1	1	1	...	...	...	...	...	...
Port Officer and Relgistar of Wrecks, Calcutta	2	...	...	...	1	4	600	125	225	350
Post Master Generat, Bengal	34	65	70	34	...	...	...	...	...	...
Private Secretary to the Viceroy	1	4	4	1	1	...	33	...	33	33
Protector of Emigrants, Calcutta	...	...	...	...	...	4	1,136	568	...	568
Quarter Master General in India	65	59	69	39	70	13	10,740	1,197	6,770	7,967
" " " Madras	...	...	...	...	1	...	300	...	300	300
Reporter on Economic products to Government of India	5	2	...	...	...	...	...	...	...	...
Sanitary Commissioner, Assam	...	...	...	2	2	...	500	250	...	250
" " Bengal	8	4	4	3	4	13	5,210	3,225	1,340	4,565
" " India	5	...	...	...	...	5	2,502	800	1,203	2,003
" " Central Provinces	...	...	1	1	1	...	275	...	275	275
" " Hyderabad Assigned Districts	1	...	1	...	...	1	200	...	200	200
Secretary for Berar to the Resident at Hyderabad	...	...	1	1	2	...	380	...	760	760
" of State for India	...	...	...	...	...	...	...	...	...	...
" to Lady Dufferin's Fund	1	...	...	...	...	2	3,000	1,500	...	1,500
" Mandalay Municipality	1	...	...	...	...	1	500	...	500	500
" Police Revisional Committee	1	...	...	...	...	2	100	50	...	50
Settlement Officer, Burdwan Raj Khas Mahals	...	...	...	...	...	1	480	...	480	480
Superintending Engineer, 1st Circle, P.-W. D., Burma	1	6	6	1	1	...	50	...	50	50
" " Central Provinces	1	...	...	...	...	1	200	...	200	200
" " Hyderabad	2	...	...	2	2	6	120	...	60	60
" " Sind Division	...	...	...	...	...	2	10	...	10	10
Superintendent, Army Clothing	1	...	...	...	...	1	200	...	200	200
" Campbell Medical School	1	...	...	...	...	1	200	...	200	200
" Census Operations, Assam	12	2	2	2	1	26	16,250	5,000	1,850	6,850
" " " Berar	14	...	...	...	...	...	...	...	...	...
" Government Press N.-W. P. and Oudh	...	...	...	...	...	1	710	...	710	710
" Government Printing, India	50	17	15	13	10	14	27,522	4,308	39,530	43,838
" " Records	14	10	4	1	2	...	1,000	...	2,000	2,000
" of Emigration, Calcutta	2	...	...	...	...	4	16	8	...	8
" Presidency Jail	3	...	...	...	...	3	900	...	900	900
" of Stationery, Calcutta	...	...	...	...	...	2	2,880	...	2,880	2,880
" Telegraph Stores	1	...	...	...	...	1	100	...	100	100
" of Works, P. W. D., Kohima	3	...	13	13	6	6	102	...	102	102
" Zoological Gardens	...	...	...	...	...	...	...	...	...	...
Special work done for Trade and Private Individuals	13	24	25	14	26	7	35,502	6,300	23,502	29,802
Total	1,424	1,079	1,032	526	609	497	475,845	114,445	363,248	477,693

LITHOGRAPHIC OFFICE.

Departments, etc., during the year 1891-92—continued.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.		
			368	75		40	36,887	40		£ a. p. 57,326 0 3	
							800			655 4 0 96 0 0	
										49 3 3 22 2 9	
										56 15 3 74 7 3	
										368 15 0 772 14 0	
			20							30 0 0 282 0 0	
						1	1,552	3		35 0 0 65 15 9	
										12 9 6 139 8 9	
										1,086 7 0 64 15 6	
										150 6 0 3,507 15 6	One subject not yet printed.
			8							68 8 9 144 1 9	Ditto ditto.
				2						57 5 6 406 3 0	
			1							480 2 0 37 6 6	
										31 12 6 37 3 0	
			2,136							1,159 3 0 99 7 0	
										110 1 0 30 4 0	
										74 11 0 88 8 6	
										26 0 0 304 13 3	
										10 15 0 21 7 0	
										18 7 0 770 10 9	
										273 0 0 56 6 0	
							9	9		1,249 4 9 153 4 3	
				20						47 8 0 121 2 0	
										122 4 0 21 7 0	
										235 14 6 198 0 0	
			50	12			1,650			1,425 11 3	
...	...	...	2,583	109	...	41	40,898	52	...	72,677 12 0	

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Detail of Issues to, and Receipts from, Provinces and Departments during the financial year 1891-92.

PROVINCES AND DEPARTMENTS.	RECEIPTS. Value.	ISSUES. Value.	DEBITS. Value.	CREDITS. Value.
	₹	₹	₹	₹
Assam	706	22,240	21,534	...
Bengal, Civil	18,842	30,507	11,665	...
„ Military	4,789	10,620	5,831	...
Berar	36	1,085	1,049	...
Bombay, Civil	12,097	4,053	...	8,044
„ Military	1	1,329	1,328	...
Burma	925	50,412	49,487	...
Central India	405	...	...	405
Central Provinces	168	8,236	8,068	...
Forests	1	2,896	2,895	...
Geological Survey and Museums	374	1,393	1,019	...
Guaranteed Rys.,—East India Railway	...	152	152	...
„ Rajputana Malwa Railway	...	230	230	...
Inland Custom	...	6	6	...
Law and Justice (Port Blair)	...	2	2	...
Land Revenue, Coorg	...	377	377	...
Hyderabad, P. W. D.	...	936	936	...
Madras, Civil	3,262	20,668	17,406	...
„ Military	441	2,832	2,391	...
Marine	1,076	1,304	228	...
Medical	...	18	18	...
Meteorological	940	1,369	429	...
Mint	1,727	13	...	1,714
Native States, Jaipur	1,101	12	...	1,089
Neemuch Cantonment Fund	...	10	10	...
N.-W. Provinces	...	150	150	...
N.-W. Provinces and Oudh	644	13,868	13,224	...
N.-W. State Railway, P. W. D.	3,037	7,746	4,709	...
Political	...	285	285	...
Public Works, Military Works	3,576	7,222	3,646	...
„ Coorg	20	219	199	...
„ Baluchistan, Railway Branch	19,614	12 914	...	6,700
„ „ Ordinary „	...	1,418	1,418	...
Punjab	2,992	17,494	14,502	...
Rajputana and Central India	1	507	506	...
Survey of India	16,370	86,255	69,885	...
Telegraph	...	91	91	...
TOTALS	93,145	3,08,869	2,33,676	17,952
NET DEBIT	...	...	2,15,724	
CASH SALES	...	23,137	23,137	
GRAND TOTAL	...	...	2,38,861	

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1891-92.

Specification.	Number.	Value. R	Value. a.
Cards for marine compasses	1	19	2
Cases, leather and morocco, spare	325	532	12
Chains, measuring, iron, 66 feet	80	280	0
„ „ „ 100 „	10	70	0
„ „ steel	3	45	0
Clocks	1	25	0
Compasses, bow dividers, brass jointed	200	250	0
„ „ ink „ single jointed	100	137	8
„ „ „ electrum „ „	3	19	8
„ „ „ „ double „	6	36	0
„ „ pencil „ „ „	6	38	0
„ „ set spring	1	20	0
„ drawing, ordinary brass, 5-inch	2,717	2,314	14
„ magnetic pocket, in brass cases	6	215	4
„ „ „ in electrum cases	10	227	8
„ „ rectangular, 5-inch	4	40	0
„ proportional, electrum 6 „	6	93	3
„ „ „ 9 „	1	18	0
Covers for plane-tables	36	207	0
Glasses, magnifying, reading, folding, 4-inch	1	6	12
„ „ „ in metal frame, 1-inch to 4-inch	24	58	8
„ measuring, for raingauges, 5-inch	800	1,500	0
„ jars test for hydrometers	287	309	7
Hold-alls, leather	24	84	0
Hydrometers, Syke's brass floats, sets	6	321	6
Hygrometers, Mason's	32	367	4
Instruments, drawing, Addiscombe and Royal Engineers pattern	3	94	8
„ „ brass, 1st sort	2	97	3
„ „ „ 2nd „	1	35	0
„ „ „ 3rd „	1	17	0
„ „ electrum, 1st sort	5	289	4
„ „ „ 1st „ with needle points	2	113	0
„ „ „ 2nd „	1	36	0
„ „ „ 3rd „	1	22	0
Lamps, bull's eye	9	22	11
Level, reversible, 12-inch	2	520	0
„ „ 14-inch	2	520	0
„ spirit, in wooden cases, 8-inch to 10-inch	314	750	6
Map printing machine, Ordnance pattern	21	892	8
Numbers for chains, sets	3,050	857	13
Ghât tracers, Ceylon pattern	2	105	13
Pencil, lead, for instruments	6	6	0
Pins for chains, ordinary	23,000	1,437	8
„ „ revenue survey pattern	100	18	12
„ „ maps, brass	864	51	0
„ „ „ electrum	50	3	2
Plane-tables, deal	156	1,074	0
Protractors, horn	2	4	8
„ rectangular, electrum, 6-inch	13	92	0
„ „ ivory, 6-inch	190	786	12
„ „ wooden	12	19	8
„ „ Sandhurst pattern	10	17	8
Rules, carpenter's wooden, 2 feet, 2 fold	12	10	8
„ „ „ 2 „ 4 „	180	234	0
„ flat ebonite, plain, 6-inch	200	175	0
„ „ „ „ 12 „	200	281	4
„ parallel bar, ivory	13	52	8
„ „ „ wooden 6-inch	15	14	4
„ „ on rollers, electrum, 6-inch	1	13	0
„ „ „ „ 12 „	1	60	0
„ „ „ wooden, 6 „	150	112	8
„ sight, wooden	458	1,366	0
Carried over	33,739	17,338	12

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1891-92.—continued.

	Number.	Value.
		₹ a.
Brought forward	33,739	17,338 12
Specification—continued.		
Scales, diagonal, metal, 6-inches to the mile	24	17 1 0
„ „ wooden	1,000	406 4
„ offsets, sets, ivory	1,510	479 11
„ „ single	1,000	343 12
„ plotting sets, wooden	12	18 1 8
Sectors, ivory, 6-inch	6	3 0 0
„ wooden, 6-inch	12	2 1 0
Set squares, set, ebonite	9	3 1 14
„ „ single, „	6	1 2 8
Slide rules	12	186 12
Squares, optical	256	1,646 0
Stands for levels, dumpy and Y	3	120 0
„ „ plane-tables, survey pattern	856	5,974 0
Tapes, metallic, 50 feet	305	1,304 10
„ „ 66 „	25	129 12
„ „ 100 „	40	290 0
„ steel, 100 „	1	23 12
„ „ other sizes	2	3 2 0
Thermometer, clinical	10	33 2
„ for hygrometers	8	49 0
„ maximum, self-registering	5	60 0
„ maximum and minimum, sets, 9-inch	1	30 0
Trunks, mule	6	87 0
Umbrellas, surveying	18	328 8
Watches, common	44	518 0
TOTAL	38,910	29,928 13
Books.		
Manual of Surveying	3	36 0
Nautical Almanac	125	240 10
Tables, Barometrical, Mackesy's	35	61 4
„ hypsometer	24	37 8
„ Log., Chambers	24	66 0
TOTAL	211	441 6
Sundries.		
Brushes, stencil, medium size	61	29 0
Glass ink bottles	3	3 9
Boxes, Faber's artist leads	3	3 0
Compass, bronze	1	27 0
„ prismatic prison	4	6 0
Eye-piece, spare, for Scott's telescopic sight	6	41 7
Flexible chains for Watkin's aneroid	6	11 10
Gauge glasses	24	9 8
Glasses, lubricator	24	27 10
Iron cylinders	2	355 0
Rings, india-rubber	48	3 4
Telemeters	2	375 0
Type-writer	1	300 0
Wire, fine	10	0 6
TOTAL	195	1,192 6
TOTAL OF INSTRUMENTS	38,910	29,928 13
„ BOOKS	211	441 6
„ SUNDRIES	195	1,192 6
GRAND TOTALS	39,316	31,562 6

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1891-92.

	Number.	Value.	
Specification.		£	a.
Board, drawing, deal	25	342	0
,, ,, mahogany and teak	1	10	0
,, padded, for thermometers	3	7	8
Chains, measuring, iron, 33 feet	110	275	0
,, ,, ,, 66 ,,	2,484	8,423	0
,, ,, ,, 100 ,,	127	730	0
,, ,, steel	57	676	0
,, of other sorts and sizes	14	77	0
Clinometers, road, reflecting, Cooke's pattern	6	312	0
,, survey pattern	18	540	0
,, wooden, with shade scales	87	130	8
Combs, acre, card board	3,900	1,462	8
Compasses, magnetic, pocket, in electrum cases	24	168	0
,, ,, rectangular, 5-inch	109	1,460	0
,, ,, ,, 6 ,,	159	2,400	0
Curves, railway, wooden, single	6	3	0
Glasses, copying or tracing	20	793	4
,, measure, for raingauges of sizes	23	92	0
,, ,, ,, ,, 5-inch	53	106	0
Hold-alls, leather	31	520	0
Lamps, argand	9	945	0
,, referring	11	55	0
Pins for chains, ordinary	2,755	187	3
,, ,, maps, electrum	24	3	0
Plane-tables, deal, survey pattern	562	3,784	0
,, ,, military ,,	1	4	0
Plates, graticule	3	150	0
Pluviometers, Simon's	870	5,676	0
Protractors, card board, circular, 12-inch	100	125	0
Rules, flat ebonite, plain, 6-inch	160	61	14
,, ,, wooden ,, 12 ,,	219	37	15
,, parallel, on rollers, brass, 12-inch	12	210	0
,, sight, brass	20	169	0
,, ,, wooden	162	570	0
Scales, card board, miscellaneous	250	62	8
,, diagonal, card board	4,755	933	12
,, ,, metal, 2 inches to the mile	250	750	0
,, ,, ,, 6 ,, ,,	52	260	0
,, graticule or co-ordinate	75	93	12
,, horn	83	62	4
,, offsets, sets, ivory	20	10	0
,, ,, ,, wooden	40	10	9
,, ,, single, ivory	49	18	6
,, ,, ,, wooden	509	130	6
,, plotting sets, ebonite	1	18	6
Squares, acre, horn	6	3	0
Stands for heliotropes	24	216	0
,, ,, plane tables, survey pattern	52	364	0
Staves, levelling, Sopwith's	100	2,500	0
,, subtense	16	425	0
Stencil plates, various	441	1,026	0
Sundials	1	65	0
Yards, standard	2	11	8
TOTAL	18,891	27,465	10
Books.			
Tables, log: Shortrede's, numbers	36	9	0
,, for reducing slopes to the horizontal	100	25	0
Carried over	136	34	0

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1891-92—continued.

	Number.	Value.
		₹ a.
Books—continued.		
Brought forward	136	34 0
Height indicator, Captain Wahab's, on thin paper	24	9 0
,, ,, ,, on card board	24	9 0
Traverse indicator, Reynold's, on card board	75	187 8
TOTAL	259	239 8
Sundries.		
Links for chains	50	4 11
Numbers, brass, single and sets	10	7 8
Plummets, brass	12	18 0
Screws, brass, for plane-tables	14	21 0
Bolts for plane-tables with nuts	6	19 8
Box, fitted with object and reflector	1	25 0
Gauges, electrum	350	787 8
Ice box	1	10 0
Parts of subtense bar, brass	1	17 8
Screw driver for theodolite	6	
Wrenches for ,,	6	5 0
Pins for ,,	12	
Plan stand	1	60 0
Scales, brass, 2 feet divided to $\frac{1}{32}$-inch	1	10 0
,, horn	6	12 0
Screw-driver for instrument box	3	0 12
Tin tubes	4	7 0
Type-holders	4	89 8
Water gauge	1	8 8
Zinc muller	1	2 8
TOTAL SUNDRIES	490	1,105 15
,, BOOKS	259	239 8
,, INSTRUMENTS	18,891	37,465 10
GRAND TOTALS	19,640	38,811 1

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in workshop during the financial year 1891-92.

	Number.
Specification.	
Air pump	1
Altazimuth pocket compass	1
Anemometers	12
Anemograph	1
Arithmometers	6
Barometers of sorts	50
Boards, drawing, of sorts	1
Camera	1
Chains of sorts	51
Chronograph	1
Chrono-micrometers	3
Chronometers of sorts	5
Circumferenter	1
Clinometers of sorts	29
Carried over	163

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in workshop during the financial year 1891-92—continued.

	Number.
Specification—continued.	
Brought forward	163
Clocks	4
Compass, azimuth	1
Compasses, beam, of sorts	4
„ boat	1
„ bow dividers, spring	1
„ „ pens, of sorts	20
„ „ pencil	2
„ „ sets	1
„ drawing, of sorts	45
„ hair, of sorts	5
„ magnetic, pocket	7
„ for pen and pencil, of sorts	3
„ Napier's	1
„ prismatic, of sorts	79
„ proportional	5
„ rectangular, of sorts	36
„ surveying, of sorts	43
Declinometer	1
Glasses, binocular	24
Heliographs	46
Heliotropes	20
Horizon, artificial	1
Hydrometers	56
Hygrometers	2
Instruments, drawing, of sorts	43
Lamps of sorts	5
Levels of „	119
„ reflecting	4
„ spirit	10
Machines, map printing, of sorts	6
Magnets, bar	2
Mining dials with stands	2
Pens, drawing, of sorts	114
Pentagraphs of sorts	3
Perambulators	1
Pins for chains	40
Plane-tables of sorts	107
Planimeters	9
Pointer, station	3
Protractors of sorts	5
Quintants	9
Raingauges of sorts	12
Range-finders of sorts	39
Rules of sorts	31
„ sight for plane-tables	79
Scales of sorts	18
Scott's sight telescopes	8
Sector, ivory	1
Sextants of sorts	9
Solar attachment	1
Squares, optical	194
Stands for compasses, of sorts	49
„ for heliographs	6
Stands for levels	67
„ „ plane-tables	104
„ „ range finder	1
„ „ telescopic	1
„ „ theodolites	37
Carried over	1,710

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in workshop during the financial year 1891-92—concluded.

	Number.
Specification—concluded.	
Brought forward .	1,710
Staves, levelling, of sorts	126
T. square	1
Tapes of sorts	186
Telescopes of sorts	139
Theodolites of sorts	77
Thermometers of sorts	15
„ for hydrometers	14
„ for hygrometers	5
Type, hand press	1
Umbrella	1
Watches	9
TOTAL OF PRINCIPAL INSTRUMENTS REPAIRED . .	2,284
„ MINOR INSTRUMENTS REPAIRED . . .	1,407
TOTAL OF ALL INSTRUMENTS REPAIRED . .	3,691

Profit and Loss Account of the Workshop for the financial year 1891-92.

DEBITS.	R	a.	CREDITS.	R	a.
Workshop establishment (less proportion debitable to the store branch for cleaning and adjusting serviceable instruments)	37,488	11	By repairs for public officers on book debit . R15237-8 By repairs for public officers on payment . R4 403-15	19,641	7
One-third of office establishment	2,327	14	By repair for stock . .	37,527	15
Pay of Material Store-keeper for the whole year . .	780	0	By manufactures for stock :—		
Workshop contingencies, as distinguished from materials purchased . . .	2,532	2	Instruments . .	37,173	9
			Packing cases . .	2,268	10
Value of materials :—					
For special work .					
„ general workshop use .	29,308	14			
„ manufacture of packing cases .					
Cost of repairs . . .	41	0	By manufacture of materials .	5,411	8
Wear and tear of plant . .	2,111	3			
Half rent at R600 per mensem	3,600	0			
Printing and stationery .	336	9			
Four per cent. on value of tools and plant amounting to R96,769 . .	3,870	12			
Add cost of printing done in Surveyor-General's Office during 1890-91, omitted from last year's account . .	1,434	8			
Profit	18,191	8			
TOTAL .	1,02,023	1	TOTAL .	1,92,023	1

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Extract from the Narrative Report of MR. J. ECCLES, M.A., *in charge Computing Party, Season 1891-92.*

The following changes in the personnel took place during the year under report :—

For three months, whilst Mr. Eccles was on privilege leave, Captain S. G. Burrard, R.E., held charge. Mr. A. Christie was posted to the Computing Section from No. 24 Party on the 1st May 1892 to relieve Mr. L. J. Pocock, who was subsequently transferred to the Head-Quarters Office, Calcutta, on 17th July 1892. Mr. C. H. McA'Fee and Mr. H. G. Shaw interchanged places in the Drawing and Computing Sections for about three and a half months. Amongst the computers, eight new hands were entertained, and three resigned during the year.

The cost of the Computing Section under its various class heads, and the percentages thereof, with those of the two prior years, are given in the following statement :—

Class.	Cost in Rupees.	Percentage of Cost.		
	1891-92.	1891-92.	1890-91.	1889-90.
1. Records, Library	1,504	3	3	4
2. Accounts, returns, correspondence	2,030	4	5	5
3. Supply of data, etc.	1,275	3	1	2
4. Computations	10,418	...	...	...
5. Preparation of press copy	17,387	79	74	71
6. Examination of press proofs	7,887	...	...	...
7. Ditto of charts	1,086	2	4	1
8. Protection of stations	446	1	1	2
9. Miscellaneous	2,579	6	9	11
10. Meteorology and general science	664	1⅔	2	2
11. Extra-departmental work	158	⅓	1	2
Total	45,434	100	100	100

The percentages for classes 4, 5, and 6 again show a marked improvement on those for the preceding years ; the other classes need no remark, excepting class 3, of which the percentage is still high ; this is again entirely due to the unusually heavy demand for data from the field parties, most of which had to be transcribed and compared and some computed in duplicate.

The following is an account of the work done under the several classes shown in the foregoing table :—

CLASS 1—RECORDS, LIBRARY, ETC.—Five fresh instalments of field records were received during the year ; these, together with the great mass already stored in the office, have received the same care and attention as heretofore. There is nothing to notice regarding the library beyond the bringing up to date of the three copies of the catalogue for all books and periodicals received from time to time.

CLASS 2—ACCOUNTS, RETURNS, AND CORRESPONDENCE.—This includes indents, estimates, monthly detailed and abstract progress reports, annual report, stock returns of ordnance stores, and various other items. In this class is also included the cost of binding of three synoptical volumes.

CLASS 3—SUPPLY OF DATA.—Requisitions from officers for data of various kinds have been met ; the work connected with the despatch of maps, charts, books, and forms is also included under this head.

CLASS 4—COMPUTATIONS.—These are detailed under the heads of the several series given below ; they appertain mostly to secondary work of the Southern Trigon, including Colonel Lambton's triangulation, and of the South-West Quadrilateral. The reduction of the Great Arc series, which now stands completed, was in the hands of two pairs of the most experienced computers during the whole year ; but very heavy work still remains to be done in the compilation of the results which will be noticed in class 5. The progress made is as follows :—

(1) The Madras Longitudinal Series.	Finished.
(2) The Great Arc, Sections 8° to 18°, Series.	
(3) The Abu Meridional Series.	
(4) The Gujarat Longitudinal Series.	
(5) The Khánpisará Meridional Series.	
(6) The Singi Meridional Series.	
(7) The Cutch Coast Series.	
(8) The Kathiawár Meridional Series.	About one-fourth done.

A small catalogue, showing star places as deduced from the latitude and longitude observations of this Department, is still in hand ; two computers have been engaged in this work for eight months.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Electro-Telegraphic Longitude.—This consisted in revising most of the calculations for the several arcs contained in Professional Volumes IX and X, and the simultaneous reduction of the whole of the longitude arcs for Professional Volume XV. These have taken the time of two computers for eight and a half months. The revision of two arcs of Volume IX still remains to complete the work.

The following aid was rendered to field parties :—

Two computers were lent for seven weeks to the astronomical parties for the completion of the latitude calculations of season 1890-91, and of the electro-telegraphic longitude work of season 1891-92.

There was other work of this class of a miscellaneous character.

CLASS 5—PREPARATION OF PRESS COPY.—This entails abstracting and compiling the final results of the various calculations in a suitable form for publication : all such abstracts are twice compared both against the original field records and the final calculations prior to being sent to the press. The details of the work are as follows :—

(*a*) *Southern Trigon.*—Great progress has been made with preparation and final revision of the several tabular statements for the synoptical volumes. All those for the Bombay Longitudinal, Madras Longitudinal, and Madras Meridional and Coast series have been entirely completed and passed for the press : those for the only remaining series of the Trigon, *viz.*, the Great Arc, section 8° to 18°, are now in hand, and a little progress has been made, but this will entail some heavy work, not only on account of the great length of the series about 700 miles, but chiefly on account of a very large portion of Colonel Lambton's triangulation falling within the area covered by this series.

(*b*) *South-West Quadrilateral.*—The progress made in the preparation of the several tabular statements for the synoptical volumes is likewise very great ; those for the Abu Meridional and Gujarat Longitudinal series were commenced and completed ; of the Khanpisura Meridional, Singi Meridional and Cutch coast series half was done, and there remains only the Kathiawar Meridional series to complete the whole of the secondary work of this quadrilateral.

(*c*) The pamphlet of spirit-levelled heights, No. 6, Bombay Presidency, was passed through the press.

(*d*) *Electro-Telegraphic Longitude.*—One hundred pages containing observations and results of season 1891-92 were examined and passed for the press.

(*e*) *Tidal Volume.*—Considerable progress has been made in the compilation of the several introductory chapters of which the first twelve pages have been finally passed through the press.

(*f*) *Burma Coast Series.*—Forty pages of the observed angles were prepared and passed ; this was done to keep the presses fully employed when unavoidable interruptions occurred in passing the regular work.

CLASS 6.—EXAMINATION OF PRESS PROOFS.—This consists in passing proofs, all requiring the utmost care in comparison and examination in the several stages of first, second, and form proof. Most of the matter printed is numerical or depending on numerical data, hence it necessarily requires a very critical examination which can only be made by men specially trained to this style of work.

The printing of the following works have been completed during the year :—

(1) Synoptical volume XXV.
(2) „ „ XXVI.
(3) Pamphlet of spirit-levelled heights, No. 6, Bombay Presidency.
(4) One Exploration Report (reprint).
(5) Calendar for Forest School.

Nos. (1), (2) and (4) have been bound and issued and No. (3) is ready for issue.

The printing of synoptical volumes XXVII, XXVIII, and XXX is nearly finished, and they will be ready for binding in a couple of months.

CLASS 7—EXAMINATION OF CHARTS.—The following charts were examined and passed for the press :—

(1) Ten final charts for synoptical volumes XXV, XXVI, XXVII, XXVIII and XXX.
(2) One level chart for pamphlet of spirit-levelled heights, No. 6, Bombay Presidency.

In addition, nine rough working charts for synoptical volumes XXV, XXVII and for the Khanpisura Meridional series were prepared, without which the compilation of the tabular details would have been very materially delayed.

CLASS 8—PROTECTION OF STATIONS.—The usual professional aid in connection with the protection of survey stations and certain of the bench marks in the North-Western Provinces has been rendered by the Computing Section to the office of the Deputy Surveyor-General. During the year 573 stations have been repaired by the district officers at a cost of R1,877-14-6. Thirty-three districts out of 334, from which reports are due, failed to submit them.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

CLASS 9—MISCELLANEOUS.—This includes various duties which cannot fairly be assigned to any of the other classes, such as the following :—

(*a*) The taking and reducing of observations for time at Mussooree and Dehra, for rating clock and chronometers, and for giving the signal for the 12 o'clock gun at Mussooree.

(*b*) The preparation of examination papers for the Senior and Junior divisions of the Survey of India Department, of which one set was prepared and examined for the Junior division.

(*c*) The examination and despatch of printed papers to the Survey of India Office, Calcutta, for safe custody; the giving out of printed pages of synoptical volumes to binders; the examination of all bound volumes and pamphlets, prior to issue, and the preparation of the distribution list for the same, etc., etc.

In addition, three officers of the Junior division have received special instructions in the use of instruments appertaining to the scientific work of this branch.

CLASS 10—METEOROLOGY AND GENERAL SCIENCE.—A complete set of meteorological observations was taken daily throughout the year, and monthly and annual abstracts prepared. The details are furnished in the following tabular statements :—

MEAN MONTHLY READINGS OF EARTH THERMOMETERS.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25.6	1891-92	75·95	76·26	76·18	75·92	75·57	75·22	74·68	74·39	74·45	74·79	76·16	77·44
	Mean 1881—91	76.82	76·88	76·66	75·92	75·34	74·74	74·25	74·03	74·01	74·32	75·31	76·40
12·8	1891-92	78·67	77·66	76·07	74·13	72·50	71·61	72·25	74·32	76·39	77·92	79·79	80·40
	Mean 1881—91	79·44	77·92	75·47	72·77	71·16	70·59	71·33	73·11	75·17	77·04	78·97	79·60
6·4	1891-92	78·97	75·51	71·67	68·39	67·46	68·08	73·97	79·00	81·66	82·68	81·90	81·42
	Mean 1881—91	79·70	75·62	70·94	67·07	65·42	67·27	71·52	76·58	79·99	81·15	81·33	81·21
3·2	1891-92	77·28	71·75	66·60	63·68	63·99	68·79	79·70	84·64	86·26	84·92	81·97	81·77
	Mean 1881—91	78·20	71·60	65·45	61·84	61·21	66·78	75·14	81·41	84·57	83·28	82·11	81·65
1·1	1891-92	74·06	67·42	60·19	58·09	60·54	69·47	82·31	87·12	89·16	85·17	81·50	81·12
	Mean 1881—91	76·17	67·44	60·22	57·42	58·45	67·83	78·73	85·30	88·09	84·08	82·50	81·73
Thermometer in shade.	1891-92	76·92	73·61	67·69	67·22	68·08	85·78	96·63	97·64	92·74	83·21	79·08	82·19
	Mean 1881—91	81·08	73·83	68·57	64·47	67·55	78·57	89·76	93·31	91·12	82·51	80·80	82·58

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DÚN.

Mean velocity in miles of the Winds which blew at Dehra Dun during the twelve months of 1891-92 for each hour of the day.

Civil hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Mean.
0 to 1	2·17	1·79	1·19	0·77	0·79	1·28	1·63	1·32	1·60	0·71	0·06	0·45	1·15
1 „ 2	1·53	1·55	1·13	0·83	0·59	0·93	1·60	1·06	1·97	0·65	0·09	0·48	1·03
2 „ 3	1·20	1·07	0·84	0·50	0·66	0·76	1·03	1·10	1·43	0·71	0·03	0·34	0·81
3 „ 4	0·93	1·00	0·77	0·33	0·52	0·48	1·10	0·84	1·07	0·65	0·13	0·38	0·68
4 „ 5	0·97	1·03	0·52	0·30	0·31	0·38	0·63	0·77	1·41	0·68	0·13	0·45	0·63
5 „ 6	1·10	0·83	0·57	0·23	0·38	0·24	0·97	0·77	1·41	0·61	0·06	0·41	0·63
6 „ 7	1·03	0·90	0·60	0·20	0·24	0·24	0·70	0·97	1·07	0·45	0·09	0·28	0·56
7 „ 8	0·60	0·79	0·59	0·07	0·21	0·24	0·70	0·81	1·00	0·65	0·06	0·45	0·51
8 „ 9	0·57	0·66	0·41	0·17	0·31	0·42	0·63	1·03	1·17	0·71	0·13	0·30	9·54
9 „ 10	1·30	1·10	0·86	0·33	0·35	0·58	1·67	1·68	2·00	1·00	0·39	0·74	1·00
10 „ 11	1·91	1·52	1·20	0·67	0·86	1·53	2·40	2·68	2·14	1·45	0·97	1·00	1·53
11 „ 12	1·93	1·90	1·70	1·03	0·93	1·93	2·77	3·06	2·38	2·10	0·87	0·93	1·79
12 „ 13	2·00	2·31	1·87	1·35	2·10	2·83	3·23	3·23	2·66	2·26	1·20	0·93	2·16
13 „ 14	2·23	2·45	2·03	1·74	2·43	3·83	3·67	4·00	3·41	1·84	1·29	1·21	2·51
14 „ 15	2·00	2·45	2·16	2·03	2·54	4·10	4·10	5·29	3·28	2·32	0·90	1·55	2·73
15 „ 16	1·52	1·86	1·71	1·93	2·11	3·80	4·10	5·13	3·66	2·06	0·74	1·69	2·53
16 „ 17	1·13	1·17	1·10	1·43	1·93	3·90	3·57	5·20	3·28	1·90	0·45	0·90	2·16
17 „ 18	0·39	0·28	0·26	0·17	1·00	2·27	2·40	4·32	2·03	1·32	0·32	0·17	1·24
18 „ 19	0·81	0·86	0·42	0·13	0·25	0·23	0·83	2·58	1·62	0·97	0·26	0·28	0·77
19 „ 20	1·61	1·93	0·77	0·30	0·25	0·37	0·77	1·23	1·06	0·81	0·13	0·55	0·81
20 „ 21	1·97	2·47	1·23	0·43	0·36	1·03	1·53	1·06	1·03	0·65	0·16	0·41	1·03
21 „ 22	2·10	2·48	1·61	0·80	0·90	1·17	1·53	1·03	1·30	0·71	0·23	0·41	1·19
22 „ 23	2·52	2·55	1·65	1·07	0·86	1·03	1·83	1·23	1·43	0·58	0·19	0·52	1·29
23 „ 24	2·52	1·97	1·61	0·87	0·90	1·17	1·73	1·29	1·70	0·55	0·09	0·76	1·26
Sums	36·04	36·86	26·80	17·68	21·78	34·74	45·12	51·68	45·05	26·34	8·97	15·58	...
Average	1·50	1·54	1·12	0·74	0·91	1·45	1·88	2·15	1·88	1·10	0·73	0·65	...

Monthly Meteorological Results of Observations taken at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun.

Year and Month.	Barometer reduced to 32° Fah.						Hygrometer.		Thermometer.				Rain.		Wind.	Cloud.	
	At 10 A.M.			At 4 P.M.			10 A.M.	4 P.M.	Dry Bulb.			Wet Bulb.					
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean humidity.	Monthly mean humidity.	Maximum in air.	Minimum in air.	Monthly mean in air.	Minimum.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 10 A.M.	At 4 P.M.
1891.																	
October	27·878	27·618	27·741	27·791	27·552	27·662	64	62	81·6	53·8	67·7	51·9	7	3·48	S	2	3
November	·937	·686	·796	·812	·629	·717	56	53	80·2	47·5	62·6	44·9	...	...	„	1	1
December	·986	·760	·874	·882	·629	·784	56	47	74·8	41·1	56·3	38·9	...	...	„	1	3
1892.																	
January	28·011	·708	·830	·896	·616	·734	54	43	74·9	39·0	56·3	35·9	2	0·07	Calm	3	4
February	27·828	·582	·692	·738	·514	·610	50	40	79·1	41·9	58·3	40·4	4	2·15	„	3	5
March	·755	·360	·586	·692	·247	·503	27	17	98·6	43·7	71·0	38·2	...	...	„	2	1
April	·696	·329	·540	·573	·260	·437	21	16	105·2	60·6	83·8	49·1	1	0·11	SW	1	0
May	·739	·360	·459	·633	·235	·367	28	20	108·4	63·5	86·2	52·9	6	1·39	W	1	2
June	·548	·323	·403	·436	·225	·323	50	40	102·2	65·2	83·8	60·9	7	3·60	SW	3	4
July	·470	·162	·354	·427	·078	·282	79	79	92·0	70·0	78·4	68·3	25	27·40	Calm	7	8
August	·515	·327	·454	·483	·270	·380	87	88	87·5	70·2	75·6	68·3	28	35·53	„	9	9
September	·685	·405	·528	·594	·318	·441	79	75	88·8	62·2	75·7	58·9	16	9·22	„	6	6

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

CLASS II—EXTRA DEPARTMENTAL WORK.—A pair of computers was engaged for two weeks for the Quarter Master General's Department in reducing astronomical and other observations taken by Captain H. Bower.

TYPE PRINTING SECTION.—With the exception of 302 pages printed for other departments, the working power of this section has been solely directed to the publication of the records of this branch of the Survey Department, and to the printing of most of the office and professional forms for this office and for the tidal and levelling party.

The power of this section has been found quite equal to meet all the demands made on it during the year under report, as will be seen from the following statements, wherein the out-turn contrasts most favourably with that of preceding years :—

Statement of work done during the year 1891-92.

SPECIFICATION OF PRINT.	No. of pages.	Total number of pulls.	No. of copies.	Value.
				₹
Professional Volumes	150	22,010	510	2,758
Synoptical Volumes	600	87,180	360	10,351
Pamphlets of spirit-levelled Heights	39	2,910	310	438
Letter-press for charts, map, headings, and foot-notes	215	3,790	...	1,790
Forms	302	61,048	...	2,916
Exploration Report (reprint)	39	1,460	100	465
Extra-departmental work	302	13,610	...	540
TOTAL	1,647*	172,008	1,280	19,258

* Equal to 2,228 pages of standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout :—

	1887-88.	1888-89.	1889-90.	1890-91.	1891-92.
Pages composed	1,994	1,989	1,998	2,165	2,228

An analysis of the pages composed is as follows :—

		PAGES.
PROFESSIONAL VOLUMES	Longitude operations	192
	Burma Coast Series	60
	Tidal Volume	17
	TOTAL	269
SYNOPTICAL VOLUMES	South-East Coast Series	162
	Mangalore Meridional Series	2
	Bombay Longitudinal Series	178
	Abu Meridional Series	29
	Madras Meridional and Coast Series	302
	Gujarat Longitudinal Series	77
	Madras Longitudinal Series	184
	Cutch Coast Series	18
	Káthiáwár Meridional Series	18
	Great Arc Meridional Series	36
	TOTAL	1,006
MISCELLANEOUS	Exploration report (reprint)	57
	Spirit-levelled Heights, No. 6, Bombay Presidency	34
	Letter-press for charts, map, headings, and footnotes	198
	Forms, Orders, Memoranda, etc.	374
	Extra-departmental work	290
	TOTAL	953

PHOTO-ZINCOGRAPHIC SECTION.—This section has been employed in printing maps, charts, diagrams, etc., both to illustrate the volumes published by the office and for genera use; also in printing from zinc the departmental professional forms in which mathematical formulæ are largely employed; it has also executed a large amount of extra-departmental work, as will be seen on reference to one of the following tables; about one-third the work done has been for other departments.

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The following statements exhibit the value and out-turn of work done in this section :—

Statement showing the amount and value of work done for other departments, etc., during the year 1891-92.

Departments, etc.	Photo-zincographic Printing.								Value.
	Sheets or Sections or subjects.	Negatives.	Photo-transfer Prints.	Zinc Plates.	Silver Prints.	Blue Prints.	Pulls.	Copies.	
									R a.
Forest Department	108	206	254	27	124	547	3,106	3,246	2,684 4
Quarter Master General	9	36	51	10	...	...	433	435	585 3
Miscellaneous	4	8	2	1	...	...	552	1,027	96 9
Cash sales	...	...	...	...	...	...	...	...	801 8
Total	121	250	307	38	124	547	4,093	4,708	4,166 8

Statement of Departmental work done during the year 1891-92.

Specification of Plate or Print.	Progress made.	Photo-zincographic Printing.											Remarks.
		Scale of map.	Size of each sheet.	Sheets or subjects.	Negatives.	Photo-transfer prints.	Zinc plates.	Silver prints.	Blue prints.	Pulls.	Copies.	Value.	
												R a.	
Aden, Diagram of Tidal Curves at	F	...	½ D.E.	1	1	2	1	...	...	4	8	18 7	For Professional Volume.
,, Survey, Plane-Table Sections, Sheets Nos. 1 to 8	F	4	½ D.E.	8	8	...	...	32	...	32	55 3		
,, Tidal Map	F	...	½ D.E.	1	1	2	1	...	...	4	8	22 0	For Professional Volume.
Akyab Tidal Observatory	*F	½	½ D.E.	1	...	1	...	4	...	...	4	14 10	
Anglo-Siamese Boundary Commission, 1889-90, Preliminary Map	*F	...	D.E.	1	...	...	...	...	...	50	50	10 12	
Astor and Gilghit, with surrounding country, map (corrected to 1883)	*F	4	D.E.	1	11	11	1	...	...	90	90	134 13	
Bangalore City and Cantonment Triangulation Survey, 1883-84	*F	½	D.E.	1	6	6	1	...	...	30	30	75 7	
Beypore, Diagram of Tidal Curves at	F	...	½ D.E.	1	1	1	1	...	...	8	8	12 7	For Professional Volume.
,, Tidal Map	F	8 & 1	D.E. and ½ D.E.	2	14	46	5	...	...	137	524	64 1	For Synoptical Volume XXVII.
Bombay Longitudinal Series, Final Chart, Nos. 1 and 2	*F	4	½ D.E. and D.E.	5	28	28	5	...	...	710	710	397 4	
,, Presidency, Preliminary Chart of Triangulation of the north portion, Nos. 1, 2, 3, 4 and 5	F	16	½ D.E.	1	1	4	1	...	...	150	150	356 4	
Central Provinces Survey, Index to the Forest Survey in the district of Nimar.										7	28	31 13	
Central Provinces Survey, Sheets Nos. 24 $\frac{\text{N.E.}}{1}$, $\frac{\text{N.E.}}{3}$, $\frac{\text{N.W.}}{1}$, $\frac{\text{N.W.}}{3}$, $\frac{\text{S.E.}}{3}$, $\frac{\text{S.W.}}{1}$; 25 $\frac{\text{N.E.}}{1}$, $\frac{\text{N.E.}}{2}$, $\frac{\text{N.E.}}{3}$, $\frac{\text{N.W.}}{1}$, $\frac{\text{N.W.}}{2}$, $\frac{\text{N.W.}}{4}$, $\frac{\text{S.E.}}{2}$ and $\frac{\text{S.W.}}{2}$	F & I	¼	D.E.	14	84	90	14	...	...	1,952	1,952	1,360 13	
Curve showing the Graduation errors of T. and S's 12" Theodolite No. 1	F	...	½ D.E.	1	...	1	1	...	...	24	24	10 12	
Darjeeling Survey, Sheets Nos. 1 and 2	*I	½	D.E.	2	16	...	...	...	...	...	...	91 4	
Eastern Frontier Series, Preliminary Chart, 1866-67 (in two sheets), 1877-78 (with addendum to 1876-77), and Secondary Triangulation to Bangkok, 1878-80.	*F	4	D.E.	4	16	28	4	...	...	120	90	274 2	
Eastern Turkistan, Preliminary Map, 1873-74	*F	40	D.E.	½	6	6	½	...	...	34	34	75 15	
Forms for Departmental use (Miscellaneous)	F	...	...	16	4	24	5	...	...	1,689	2,451	384 11	
Ditto ditto (Professional)	F & I	...	...	16	4	98	20	...	...	5,903	6,818	1,253 9	
Hazara Expedition, 1891, Nos. 1 and 2	F	½	D.E.	2	12	12	2	...	...	370	370	268 12	
Jaunsar-Bawar Survey, 1874—76	*F	1	D.E.	1	...	...	...	...	...	75	75	18 6	
Karachi, Diagram of Tidal Curves at	F	...	½ D.E.	1	1	4	1	...	...	2	8	30 14	
,, Tidal Map	F	...	½ D.E.	1	1	4	1	...	...	2	8	30 14	For Professional Volume.
Kárwár Port, Diagram of Tidal Curves at	F	...	½ D.E.	1	1	9	1	...	...	261	516	89 12	
,, Tidal Map	F	...	½ D.E.	1	...	...	...	...	...	4	8	2 8	
Kohat Topographical Survey, Sheets Nos. 3 and 3*a*	F	½	D.E.	2	4	4	2	...	...	30	30	77 8	
Kumaun and Garhwal Survey, Shaded Sheets Nos. 7, 8, 14, 16, 20 and 25	*F	1	D.E.	6	24	36	6	...	...	318	318	418 14	
Madras Longitudinal Series, Final Chart, No. 1	I	8	D.E.	½	5	5	1	...	...	...	...	54 10	For Synoptical Volume XXVII.
,, Meridional and Coast Series, Final Chart, Nos. 1 and 2	I	8	D.E.	2	14	7	1	...	...	...	...	117 4	Ditto XXVIII.
Mandalay Series, Preliminary Chart of principal Triangulation, Nos. 1, 2 and 3.	F	4	D.E.	3	22	22	3	...	...	180	180	282 14	
Mangalore Meridional Series, Final Chart, No 2.	F	32	D.E.	1	...	6	1	...	...	360	360	82 3	Ditto XXIV.
Miranzái Expedition, 1890-91, Map of Khanki Valley (Preliminary issue)	*F	1	D.E.	2	...	12	2	...	...	152	152	136 9	
Mussooree and Landour Guide Map	*F	½	D.E.	1	...	...	...	...	...	30	30	8 4	
Nepal Boundary Survey, Sheets Nos. 1, 2, 3 and 4	F	¼	D.E.	4	24	24	4	...	...	120	120	*301 14	

North-East Longitudinal Series, Preliminary Chart, Nos. 1A, 1B, 2, 3, 4, 5 and 6	F.	4	D. E.	7	108	108	14	...	...	525	525	1,314	8	
North-East Trans-frontier, Sheet No. 7 N. W./3	* F.	2	D. E.	1	...	...	...	...	...	77	77	23	0	
North-West Trans-frontier, Himalayan Peaks, Sheets Nos. 1, 2, 5, 6 (in one); 3, 4, 7, 8 (in one); and 9	* F.	16	D. E.	3	18	18	3	...	...	75	75	224	10	
Okha Point and Bet Harbour, Tidal Map	F.	...	⅛ D. E.	1	1	2	1	...	...	4	8	22	0	For Professional Volume.
Punjab Survey, Sheets Nos. 246 (S. E.), 1 and 332 (N. W.)	F. and I.	¼ and ½	D. E.	2	9	7	2	...	...	22	22	147	1	
South-East Coast Series, Final Chart, Nos. 1 and 2	F.	8	D. E. and ½ D. E.	2	9	22	6	...	...	549	732	286	5	For Synoptical Volume XXV.
Sector for Star Constants, Diagram	F.	...	1/16 D. E.	1	1	3	1	...	...	11	33	16	8	For office use.
Self-Registering Tide Gauge, Diagram of a portion	F.	...	1/16 D. E.	2	2	...	...	8	...	...	8	21	14	For Professional Volume.
Simla and Kalka Road Survey, Sheets Nos. 2B, 3B, 4B, 5B, 6B, 4C, 5C, 6C, and 7C (Redn. of 6″ sheets)	F.	½	⅛ D. E.	9	9	8	...	...	15	...	15	71	6	
Singi Meridional Series, Rough Chart, Eastern half, upper portion	* F.	4	⅛ D. E.	1	...	...	...	...	1	...	1	1	3	For office use.
Sketch of Globe traveller, plan	F.	...	1/16 D. E.	1	1	...	...	2	...	...	2	6	5	
Specimen of Hill shading	F.	...	1/16 D. E.	1	...	2	1	...	...	27	54	11	14	For examination of candidates for Junior Division.
Ditto Italic printing	F.	...	1/16 D. E.	1	1	2	1	...	...	54	108	19	10	
Spirit-levelling Operations, No. 6, Bombay Presidency	F.	16	⅛ D. E.	1	1	4	1	...	...	78	310	43	0	For Pamphlets of Spirit-levelled heights.
Sundial, Diagram	F.	...	1/16 D. E.	1	2	2	1	...	...	6	32	24	0	
South-West Quadrilateral of the Great Trigonometrical Survey of India, Diagram	I.	...	⅛ D. E.	1	1	4	1	...	...	...	...	29	1	For Synoptical Volumes.
Trans-frontier Map, Sheet No. 9 (2nd edition)	* F.	16	D. E.	1	...	...	...	...	...	51	51	10	14	
Other maps, for office use, Surveyor-General's Office, etc.	F. and I.	...	...	76	129	482	75	...	24	4,646	2,775	4,494	13	

Copies of Maps of other Departments taken for Departmental use.

Assam, Index to the Forest Survey of Goalpara	F.	¼	⅛ D. E.	1	...	...	...	...	...	15	15	3	12	
Ditto, Map of Darugiri Forest Reserve	F.	¼	⅛ D. E.	1	4	4	1	...	...	15	15	3	5	
Berar, Index Map to the Forest Survey of Melghât taluk (revised)	F.	8	D. E.	1	...	...	...	...	...	15	15	6	6	Copies retained for office record; of maps, etc., requisitioned for by other departments, the cost of press pulls and stationery being all that is here charged to the Survey Department; the numbers in columns 5 to 8 therefore stand excluded from the totals.
Burma (Lower), Index to the Forest Survey in the east and west Salwein and part of Attaran Division, Section 1	F.	8	D. E.	1	6	12	2	...	...	15	15	6	6	
Burma (Lower), Kon Bilin Forest Reserve	F.	1	¼ D. E.	1	1	2	...	...	...	15	15	2	9	
Burma (Upper), Map of Nwamadang and Mon West Forest Reserve	F.	2	½ D. E.	2	...	...	...	...	...	30	30	12	12	
Burma (Upper), Taungdwin Range, Magwe District, Nos. 1 and 2	F.	1	D. E.	2	...	12	2	...	...	40	40	14	0	
Ganges Garhwal, Naini Tal, and Kumaun Divisions, Map of the Reserved and Protected Forests	F.	4	D. E.	1	...	...	...	...	...	15	15	5	4	
Kumaun and Garhwal Forest Survey, Sheets Nos. LII (revised edition), LIV (2nd edition), and LX (additional piece)	F.	¼	D. E. and ⅛ D. E.	3	...	7	3	...	...	45	45	14	14	
North-Western Provinces and Oudh, leased Forests in Tiri Garhwal, Nos. 226 S.E./1 and S.W./2	F.	¼	D. E.	2	...	14	2	...	...	30	30	12	12	
Punjab Forest Survey, Bashahr State, Sheets Nos. 332 N. W./2, N. W./4, S. W./2, S. W./3; 346 S. E./1, S. E./3, (2nd edition); S. W./1, S. W./3, S. W./4, (2nd edition); 347 N. E./1, N. E./2; and 352 S. W./1	F.	¼	D. E.	12	48	48	8	...	..	180	180	76	8	
Punjab, Map of Pathankot, Kullu, Kalka and Jullunder countries	F.	4	D. E.	2	...	...	...	...	...	50	25	11	2	
Other maps	F.	...	...	7	18	25	5	...	...	132	132	35	14	
TOTAL	...	...	...	219	602	1,172	194	14	72	19,538	20,586	13,538	7	

* Additional p ıts of previous publications; D. E. represents double elephant; F. represents finished; I. represents in press.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

SOLAR PHOTOGRAPHIC SECTION.—This section has no real connection with the work of this office; but was established at Dehra Dun as a matter of convenience, so that it might be under suitable supervision.

Table of working facts for the year 1891-92.

1891-92.	NUMBER OF DAYS.				NUMBER OF NEGATIVES.										NUMBER OF WORKING DAYS WHEN SOLAR PHENOMENA WERE	
	When negatives were taken.	Failures.			Solar Phenomena.								TOTAL.			
		From bad weather.	From various causes.	TOTAL.	Spots and Faculæ.		Spots only.		Faculæ only.		None.				Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″	8″	12″		
October	28	3	...	31	52	...	...	...	...	...	...	...	52	...	28	...
November	30	...	...	30	54	...	...	...	...	...	...	...	54	...	30	...
December	31	...	...	31	57	...	...	...	...	...	...	...	57	...	31	...
January	26	5	...	31	45	...	...	...	...	...	...	...	45	...	26	...
February	23	6	...	29	40	...	...	...	...	...	...	...	40	...	23	...
March	29	2	...	31	51	...	...	...	...	...	...	...	51	...	29	...
April	30	...	...	30	54	...	...	...	...	...	...	...	54	...	30	...
May	29	2	...	31	51	9	...	...	...	...	...	...	51	9	29	...
June	25	5	...	30	45	7	...	...	...	...	...	...	45	7	25	...
July	20	11	...	31	30	3	...	...	...	...	...	...	30	3	20	...
August	15	16	...	31	24	...	...	...	...	...	...	...	24	...	15	...
September	18	12	...	30	31	...	...	...	...	...	...	...	31	...	18	...
TOTAL	304	62	...	366	534	19	...	...	...	...	...	...	534	19	304	...

Eight hundred and ninety silver prints of the 8-inch, and nineteen of the 12-inch pictures were prepared, and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table contrasting visibility of sun at Dehra Dun and Greenwich.

YEAR.	AT DEHRA DUN.			AT GREENWICH.		REMARKS.
	Number of days on which negatives were taken.	Percentage of days on which negatives showed features.	Number of days when sun was invisible.	Year.	Number of days on which negatives were taken.	
1880-81*	307	96	55	1880	156	* From 1st October to 30th September following.
1881-82	328	100	37	1881	181	
1882-83	318	100	47	1882	221	
1883-84	285	100	78	1883	215	
1884-85	284	100	81	1884	154	
1885-86	290	100	75	1885	206	
1886-87	302	98	61	1886	199	
1887-88	328	91	38	1887	188	
1888-89	315	71	50	1887-88	205	
1889-90	320	78	45	1888-89	182	
1890-91	303	99	62	1889-90†	212	† Year ending 10th May 1890. Obtained from report to the Board of Visitors.
1891-92	304	100	62	1890-91	Not obtainable.	
MEANS	307	...	58	...	193	

DRAWING SECTION.—The details of the work done in this section are given in the tables which follow :—

Statement showing work performed during the year 1891-92.

TITLE OF MAP.	Number of Sheets.	Scale.	REMARKS.
		Miles per inch.	
General Maps.			
Nepal Boundary Survey—			
District Darjeeling—			
Sheets Nos. 1, 2, 3 and 4 (Mechi River).	4	1	Corrected and completed. Final press order given.
Map of the Southern Coast of Asia	2	96	For Tidal Volume. In hand.
Standard Maps.			
Baluchistan Maps	2	16	Touched up for photozincography. Final press order given.
Punjab Survey Sheet No. 332, N.W.	4	¼	Corrected and completed for reduction. Final press order given.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Statement showing work performed during the year 1891-92.

Title of Maps.	Number of Sheets.	Scale.	Remarks.
Standard Maps—contd.		Miles per inch.	
Punjab Survey Maps	4	$\frac{1}{4}$	Corrected and completed for reproduction. Final press order given.
Gujarat Survey Sheet No. 29 (2nd edition)	4	$\frac{1}{2}$	For reduction to $\frac{1}{2}$ scale. In press.
Gujarat Survey Sheet No. 27, Section 4	1	$\frac{1}{4}$	Corrected for reprints.
Central Provinces Survey (Hoshangabad and Betul).	21	$\frac{1}{4}$	Corrected and completed. Final press order given.
Mirzapur Survey Sheet No. 185, N.E.	1	$\frac{1}{2}$	Ditto ditto.
Plans.			
Dehra Municipality and Cantonments (2nd edition).	12	$\frac{1}{12}$	In hand.
Index Maps.			
Triangulation Chart of India	2	96	Brought up to date for office use.
Diagram of the S. W. Quadrilateral	1	128	Final press order given.
Nimar Forest Survey	1	16	Corrected and completed. Final press order given.
Miscellaneous Maps.			
Tidal Maps of Beypore, Kurrachee, Aden, Okha Point, and Pamban Pass.	5	Various.	In press.
Cochin, Tuticorin, Point de Galle, Port Blair, Moulmein and Colombo.	6	Various.	In hand.
Tidal Curves—Beypore, Kurrachee, and Aden.	3	...	In press.
Tracings of Mergui base-line towers	2	...	For Colonel Strahan.
Plan and elevation drawings of sun-dial	2	...	Ditto.
Sector for constants of stars	1	...	Final press order given.
Forms.			
Village Field Book	1	...	Final press order given.
Electro-telegraphic Longitude. Computation of *Cc*, *Bb*, *Aa*.	1	...	Ditto ditto.
P. 32, page 3	1	...	Ditto ditto.
Record of chronometer comparisons in Telegraphic Longitudes.	1	...	Ditto ditto.
Charts.			
Triangulation Chart, Madras Longitudinal Series	2	4	For reduction to one-half, for Synoptical Volume. Final press order given.
Triangulation Chart, Madras Meridional and Coasts Series	2	4	Ditto ditto.
Triangulation Chart, South-East Coast Series	2	1	Ditto ditto.
Triangulation Chart, Bombay Longitudinal Series	2	4	Ditto ditto.
Triangulation Chart, Bombay Island	1	$\frac{1}{2}$	Ditto ditto.
Triangulation Chart, Abu Meridional Series	1	4	Ditto ditto.
Triangulation Chart, Gujarát Longitudinal Series	1	4	For reduction to one-half, for Synoptical Volume. In press.
Triangulation Chart, Singi Meridional Series	1	4	In hand.
Triangulation Chart, Cutch Coast Series	1	4	Ditto.
Triangulation Chart, Khanpisura Meridional Series	2	4	Rough Charts for office use. Final press order given.
Triangulation Chart, North-East Longitudinal Series Nos. 1A, 1B, 2, 3, 4, 5 and 6	7	4	Rough Charts. Final press order given.
Longitude Arcs	9	96	For use of the engravers.
Spirit-levelling Operations No. 6, Bombay Presidency, Season 1890-91	1	8	Corrected and completed for reduction to one-half. Final press order given.
Maps coloured	3,037	Various.	

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Maps examined.

	No. of Sheets.
General Maps	4
Original Standard Maps	32
Index Maps	4
Miscellaneous Maps	13
Tracing of Original Maps	4
Charts	25
Photographic proofs of Standard Sheets and other Maps	303
TOTAL	385

N.B.—In addition to the above, many miscellaneous jobs have been performed, such as assisting in Photographic Office, completing Central Provinces Survey, Punjab Survey, and Forest Survey original maps in respect to heading and foot-notes, etc., for press, supplied tracings of margins of sheets to Simla Drawing Office, to Gujarát Party, and to Himalaya Party, examined confidential records, and corrected 152 photo-zincographed sheets of Central Provinces Survey.

Statement of work done for other Departments, etc., during the year 1891-92.

TITLE OF MAPS.	Number of Sheets.	Scale.	REMARKS.
		Miles per inch.	
General Maps.			
Maps showing concentration of Troops in Manipur in April 1891	1	16	Additions and corrections made to map of Assam Province for Quarter Master General in India. Final press order given.
Skeleton Route Map	1	16	Corrected for the Quarter Master General. Final press order given.
Standard Maps.			
Forest Surveys	48	Various	Completed headings, foot-notes, and references. Final press order given for Forest Survey Branch.
Miscellaneous.			
Canal Distributary and Water-Course discharge Chart	1	...	Copied explanation in Persian character. Final press order given.
Maps coloured	160	Various.	

Statement showing the value of work done for other Departments, etc., during the year 1891-92.

DEPARTMENTS, ETC.	Value.	
	R	*a.*
Quarter Master General's Department	9	14
Forest Survey Office	103	0
Deputy Commissioner, Simla	7	13
Major Clibborn, Principal, Thomason College, Roorkee	10	0
TOTAL	130	11

G. I. C. P. O.—No. 16 S. G. 22-4-93.-450.

1893.

File No. III.

Serial No. 2.

GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

Dated Simla, the 22nd May 1893.

SUBJECT.

Resolution on the General Report of the Operations of the Survey of India Department for the year 1891-92.

G. C. Press, Simla.—No. 174 R. & A. D.—23-5-93.—670.

Extract from the Proceedings of the Government of India in the Revenue and Agricultural Department,—No. $\frac{8}{111}$. *(Surveys), dated Simla, the 22nd May 1893.*

RESOLUTION.

THE report for the year ending 30th September 1892 is, as usual, well compiled and accompanied by excellent maps and plates.

2. Twenty-one parties and six small detachments were employed on field operations during the year, as shown in the following list :—

	Number of parties.	Number of detachments.
1. Trigonometrical	1	...
2. Topographical	3	2
3. Forest	4	...
4. Cadastral	7	2
5. Traverse	1	1
6. Scientific	3	...
7. Geographical	2	1

Of these, 12 parties and 3 detachments may be held to have been engaged on remunerative operations, *i.e.*, on work connected with the enhancement of land or forest revenue.

3. The trigonometrical operations were, as in the previous year, carried on by one party only. The topographical establishment was somewhat reduced, and the outturn of work has consequently been a little less than in 1890-91. That of the Forest Surveys is, on the other hand, considerably larger than last year, mainly owing to the rapidity of the 4-inch scale operations in Madura and Coimbatore.

4. The establishment engaged on cadastral surveys has been particularly strong during the year under report, and both the outturn of work (6,598 square miles in all) and the reduction which has been effected in its cost are creditable to the Department. The extensive operations in Orissa have been carried out at an expenditure of Rs. 22 less per square mile than last year, and a considerable reduction in the rates has taken place in Upper Burma. In Garhwál the cost has been reduced from Rs. 283 to Rs. 183 per square mile

5. The Government of India notice with satisfaction the efficient manner in which during the year the Survey Department has co-operated with the Provincial Revenue authorities in the conduct of cadastral surveys. As indicated in the Government Resolutions on the survey reports of previous years, the gradual reforms which have been recently introduced, and which require, on the one hand, the more effective utilization of local agency in the construction of field maps, and, on the other, the employment of survey subordinates for the compilation of many of the registers comprised in the record-of-rights, have necessitated intimate and cordial relations between the Survey and Provincial officers. These have now been everywhere established. The amalgamation of the survey and revenue departments has, indeed, during the last year reached its fullest development in the appointment of Lieutenant-Colonel Sandeman as Director of the Bengal Surveys under the administrative orders of the Government of Bengal, and credit is due both to that officer and to Colonel Thuillier for the part which they have taken in the satisfactory arrangements which have been secured for the progress of survey operations in that Province. The instructions in the Resolution of last year on the subject of personal tours have at the same time been zealously carried out in other Provinces by Lieutenant-Colonel C. Strahan, the Deputy Surveyor General directly responsible for the superintendence of revenue

surveys, with the result that none of the difficulties which arose occasionally in previous years through want of a complete understanding between the Revenue and Survey officials have occurred during the year under report.

6. The only survey connected with the development of mining industries has been that of the detachment in Mergui and Maliwun, which has under considerable difficulties proceeded with a topographical survey of the tin and coal bearing regions in that neighbourhood.

7. General measures are under consideration for improving the pay and prospects of the Junior Division of the Survey of India. In the meanwhile, one step has been taken in this direction by securing for survey officers of the Junior Division five posts of the newly-constituted Land-Records Department in Burma.

The designation of officers throughout the Junior Division has been altered, and the Extra-Assistant Superintendents, who are at the head of the Junior Division, now rank as gazetted officers.

8. The work done in the Photographic and Lithographic office continues to show a large increase, especially in the printing sections, and it is found very difficult to comply with the demands for colour printing, even with the aid of steam machinery. The combined outturn in pulls of the lithographic and zincographic presses and machines was in 1878-79, 233,989; in 1888-89, 466,082; and in 1891-92, 756,068: these figures serve to show the increase, due in part to the introduction of steam power, in these sections. During the past year there were issued 1,318,597 impressions from print and 92,415 heliogravure prints. In 1878-79 the impressions were 367,175 only: the heliogravure prints in 1888-89, when this process was started, were 20,307.

The value of the outturn for the last three years, as compared with that for 1881-82, was—

1881-82.	1889-90.	1890-91.	1891-92.
Rs.	Rs.	Rs.	Rs.
1,69,054	2,00,374	2,08,654	2,10,357

The increased work in this office has necessitated the strengthening of the establishment.

The value of the instruments issued by the Mathematical Instrument Office at the same time has risen since last year from Rs. 2,88,337 to Rs. 3,16,373.

9. The Department continues to show good work in all its branches, and the Government of India acknowledge the services rendered by the Surveyor General and the other officers of the Department.

ORDER.—Ordered that the above Resolution be forwarded to the Surveyor General of India, Inspector General of Forests, Local Governments and Administrations noted on the margin, and to the Foreign, Military, and Public Works Departments.

Madras.
Bombay.
Bengal.
N.-W. P. and Oudh.
Punjab.
Central Provinces.
Burma.
Assam.
Coorg.

Ordered also, that the Resolution be published in the Supplement to the *Gazette of India*.

[True Extract,]

E. C. BUCK,

Secretary to the Government of India.

Photo-etching.

Survey of India Offices, Calcutta, January 1894.

SHAINSAR TEMPLE, KULU.

From a negative by Major St. G. Gore R.E.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1892-93.

PREPARED UNDER THE DIRECTION OF

COLONEL H. R. THUILLIER, C.I.E., R.E.,

SURVEYOR-GENERAL OF INDIA.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

CALCUTTA:

OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

1894.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

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PART II.

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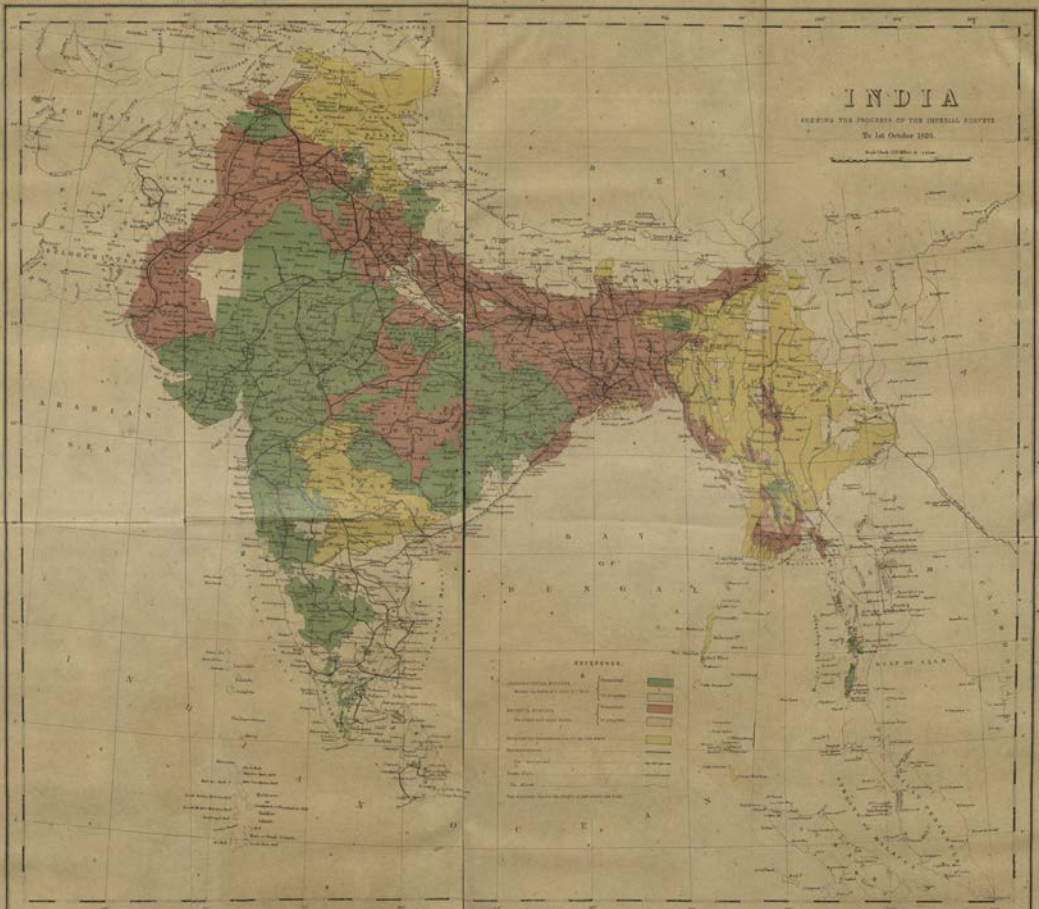
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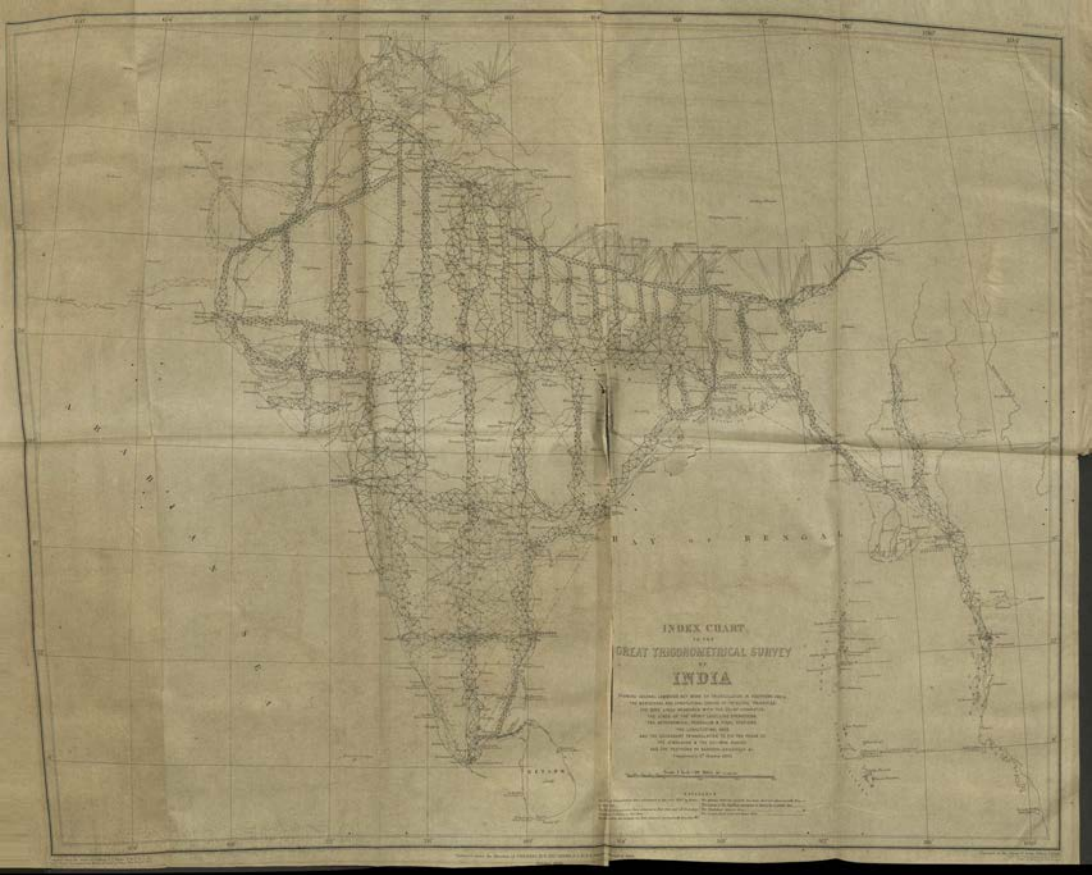
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INDIA

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1892-93.

PART I.

SUMMARY.

ADMINISTRATION.

1. The operations of the Department that are now reported on are for the survey year ending 30th September 1893.

2. The general administration of the Department and the superintendence of the Topographical Branch remained in the hands of Colonel H. R. Thuillier, R.E., during the year, except for a period of one month at the commencement while absent on privilege leave, when Colonel G. Strahan, R.E., officiated as Surveyor-General in addition to his other duties. The supervision of the Revenue Branch, the Trigonometical Branch, and the Bengal Survey Branch has remained in the hands of Lieutenant-Colonel C. Strahan, R.E., Colonel G. Strahan, R.E., and Lieutenant-Colonel J. E. Sandeman, S.C., respectively, throughout the year.

Inspection Tours of the Administrative Officers.

3. The Surveyor-General left Calcutta on the 5th April 1893 for Bangalore, and returned on the 23rd idem after inspecting the office of No. 19 Party, which is employed on forest surveys in the Madras Presidency. On the 30th April he proceeded to Simla under the orders of the Government, to be in personal communication with them, and returned to Calcutta on the 25th July. During his stay at Simla he inspected the Simla Drawing Office. He left Calcutta again on the 2nd September to inspect the parties in the Bombay and Madras Presidencies, and returned to Calcutta on the 27th idem after inspecting at Poona the offices of Nos. 10, 17, and 25 Parties, and conferring with the Survey and Settlement Commissioner regarding the operations of the Bombay Forest Survey party, and at Bangalore the offices of Nos. 11, 20, and 21 Parties and the Mergui detachment.

4. The Deputy Surveyor-General, in charge Trigonometrical Branch, proceeded to Simla in June 1893 to attend a conference held there regarding the retention of the Trigonometrical Branch Office at Dehra Dun. During his stay he inspected the office of No. 18 Party. The recess offices of the other parties under his immediate superintendence were located at his head-quarters and were duly inspected from time to time, *viz.*, those of Nos. 14, 22, 23, and 24 Parties.

5. The Deputy Surveyor-General in charge of the Revenue Branch inspected the recess office of the Garhwal detachment at Naini Tal in October 1892, and arranged for the preparation and submission of a greater number of vernacular records to the Settlement Department; he also consulted with the Secretary to the Board of Revenue on the programme of the party for the ensuing season.

During January and February 1893 he visited Burma, inspecting two of the cadastral parties, the topographical detachment in Mergui, and the forest survey party at Toungoo. It was found impossible to go by steamer from Mandalay to Minbu to inspect the third cadastral party on account of the low state of the river, and after consultation with the Chief and Forest Commissioners it was decided that the inspection of that party in the field might be postponed. The tour of inspection of the survey camps at Moulmein, Tavoy, and Mergui was made in the company of the Financial Commissioner; so ample opportunity was afforded for discussing the different questions in connection with the cadastral and topographical work in those districts, and of deciding how to meet the requirements of the Burma Government in connection with the Mergui coal-fields. The Deputy Surveyor-General whilst at Mergui was enabled, with the help of the survey steam launch, to visit the country in the neighbourhood of these coal-fields and to meet the Geological Survey Officer, Mr. Bose, with whom he ascended a hill which overlooked the whole of the area in which coal had been found. He also met the officer in charge of the topographical survey detachment there, and pointed out to him those portions of the country of which it was absolutely necessary to have a correct survey completed during the season. The cadastral camps at Thaton, Mergui, and Tavoy were also inspected, and the work of some of the *amins* and Burmans was *partalled*.

In Upper Burma, No. 3 Party was inspected in the field in Shwebo, and the work of several *amins* and Burmans was *partalled*. Lieutenant-Colonel C. Strahan also marched through the country near Letkobyin and visited the coal mines there; it was then arranged that, with the consent of the Burma Government, a topographical survey on the 1-inch scale of about 100 square miles of hilly country should be undertaken as soon as possible with a view to assist in prospecting for more coal in that neighbourhood. During an interview with the Chief Commissioner in Rangoon, Colonel Strahan arranged for the revision of the 16-inch map of Rangoon, the cost of which was to be borne by the Municipal Committee, and explained the reasons of the difference of cost between the Imperial survey parties and the local party under Mr. Clancy.

During March 1893 the Deputy Surveyor-General again went on tour and inspected No. 6 Party, which was surveying cadastrally the Jaintia *parganas* in Sylhet; he thoroughly inspected the field head-quarters camp, and also visited the *amins* in the field, *partalling* their work. This party was also visited in June 1893 at Shillong during the recess season, as some little difficulty had arisen in completing the previous season's records by the 15th September, on which date Mr. Darrah, the Director of Land Records, was likely to be transferred to the North-Western Provinces. In consultation with Mr. Darrah and the officer in charge of the party satisfactory arrangements were made.

The Financial Commissioner of Burma having expressed a wish that Lieutenant-Colonel C. Strahan should accompany him during a tour in Upper Burma to Katha on the Irrawaddy and Kindat on the Chindwin, for the purpose of discussing the best way of prosecuting the different surveys connected with settlement operations, and also that of the gold-bearing tract north of Wuntho, that officer again proceeded to Burma in September 1893, and whilst there took the opportunity of inspecting the recess offices of the cadastral parties, including that of No. 12, which had been omitted during his previous visit.

6. Lieutenant-Colonel Sandeman, Director of Bengal Surveys, left Calcutta for Bihar on the 23rd October 1892 and was engaged there till the 30th idem, arranging, in co-operation with the Director of Land Records, all the details for the season's operations. On the 31st, Colonel Sandeman returned to Calcutta, where, in consultation with the Director of Land Records, the Settlement Officer of Orissa, and Lieutenant Crichton, new rules were drawn up and arrangements made for the conduct of the operations in Orissa. On the 12th November a meeting took place at the Board's office on the same subject. On the 13th, Colonel Sandeman visited Burdwan and conferred with the Collector and Raja Bun Behari Kapur on the subject of the continuation of the survey in the Burdwan estates.

On the 16th idem he left for Chittagong, accompanied by the Officiating Director of Land Records. Meetings were held there, at which, in consultation with the Revenue authorities, a plan of operations for the completion of the

survey of the district was drawn up. On the 1st December he visited Hooghly to consult the Collector about the Rajapur drainage scheme survey, as that officer had requested that professional supervision might be given to the work. On the 4th December, Colonel Sandeman left Calcutta for Comilla, accompanied by the Director of Land Records: there they consulted the Collector and Mr. MacMinn, the Manager of the Chakla Roshnabad estates of the Maharaja of Hill Tippera, and drew up a programme of operations for the survey of the estates. On the 9th December, Dacca was visited to inspect the survey of the Talipabad *pargana* in that district. On the 12th December, Calcutta was again reached.

On the 16th idem, Colonel Sandeman left again for Bihar and was personally inspecting the survey in progress in the Muzaffarpur and Champaran districts until the 2nd February 1893. During this time he also visited Siwan, where he conferred with the Collector, Mr. Bourdillon, and with the Manager of the Hatwa Raj, Babu Bipin Behari Bose, on the projected survey of that estate. Colonel Sandeman returned to Calcutta on the 3rd February. On the 8th idem he left for Cuttack, accompanied by the Officiating Director of Land Records, between which date and the 26th idem the operations in Orissa were under inspection. The Directors were accompanied throughout by the Settlement Officer and by Lieutenant Crichton, in charge of the survey.

On the 28th February, Colonel Sandeman again proceeded to Bihar, and was inspecting in the field until the 17th March, when he returned to Calcutta. On the 20th idem he and the Director of Land Records left for Goalundo on their way to Mogra in the northern division of the Tippera estate, where they were met by Mr. Greer, the Collector, and Mr. MacMinn, the Manager. Discussions took place and provisions made to meet difficulties. On the 31st March both officers left Calcutta for Bankura, where at an interview with the Collector the difficulties of the Burdwan estates survey were gone into and measures taken to combat them. On the 3rd April, Gaya was visited: here, in consultation with the Collector, Mr. D. J. Macpherson, and Mr. Ogilvie, the Manager, plans for the projected survey of the Tikari estate were matured. On the 5th idem the Director went to Hajipur, where His Honor the Lieutenant-Governor arrived on the 8th, with whom Colonel Sandeman proceeded to Bettiah on the 10th, and returned to Calcutta on the 15th.

On the 2nd May, Colonel Sandeman proceeded to Darjeeling, whence he accompanied the Lieutenant-Governor to Calcutta on the 27th idem. On the 29th and 31st May and 2nd June he attended meetings at Belvedere, and on the 3rd June left again for Darjeeling. On the 26th idem he proceeded to Calcutta, under the orders of the Local Government, to consult the Board with respect to the contemplated changes of procedure in Bihar. On the 1st July, Colonel Sandeman, accompanied by the Director of Land Records, left for Bihar, where both officers toured about together, inspecting the Survey and Settlement offices at Muzaffarpur, Motihari, Siwan, Gaya and Dinapur, until the arrival of the Officiating Lieutenant-Governor on the 31st idem; they then accompanied him to Muzaffarpur, where a series of conferences were held, presided over by the Hon'ble Mr. C. C. Stevens, at some of which the *zamindárs* and at others the Revenue officers, Messrs. Carey and Craddock, who had been specially deputed from the Central Provinces, were present. On the 8th August, Colonel Sandeman arrived with His Honor at Calcutta. On this day a meeting was held at the Board's office, and on the 9th idem at Belvedere, where new orders regarding future procedure were issued. On the 16th August, Colonel Sandeman and the Director of Land Records proceeded to Cuttack to inspect the progress of the Orissa work, and returned to Calcutta on the 30th idem.

FIELD PARTIES.

7. The field operations of the year under report were carried on by 21 parties and 3 small detachments. Of these, one party was employed on trigonometrical surveys; three parties and two detachments on topographical surveys; four parties on forest surveys; seven parties and one detachment on cadastral surveys; one party on traverse surveys; three parties on scientific operations; and two parties on geographical surveys. The following tabular statement

shows collectively the whole of these operations, grouped according to the scope and nature of the work on which the parties were severally employed :—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Burma . . .	15	Captain C. F. Close, R.E. .	.....	D. S. G., Trig.
	Topographical Surveys.				
10	Bombay . . .	16	Major J. R. Hobday, S.C. .	2″ = 1 mile for reduction to half scale.	Ditto Rev.
15	Baluchistan . . .	17	Colonel T. H. Holdich, R.E.	6″ = 1 mile, ½″ = 1 mile, and ¼″ = 1 mile, for reproduction.	Ditto Topo.
18	Himalayas . . .	20	Major St. G. C. Gore, R.E. .	4″ = 1 mile for reproduction and reduction to half scale and 2″ = 1 mile for reproduction.	Ditto Trig.
Det.	Mergui . . .	21	Mr. J. A. Higgs . . .	1″ = 1 mile for reproduction.	Ditto Rev.
Det.	Indus River . . .	24	Mr. H. E. T. Keelan . .	1″ = 1 mile for reproduction.	Ditto Rev.
	Forest Surveys.				
14	Central Provinces .	27	Colonel J. R. Wilmer, S.C..	4″ = 1 mile for reproduction.	Ditto Trig.
17	Bombay . . .	29	Colonel H. S. Hutchinson, S.C.	16″ = 1 mile, 8″ = 1 mile, and 4″ = 1 mile, for reproduction.	Ditto Topo.
19	Madras . . .	31	Lieutenant-Colonel J. R. McCullagh, R.E.	4″ = 1 mile for reproduction.	Ditto Topo.
20	Lower Burma . .	32	Mr. E. J. Jackson . .	4″ = 1 mile and 2″ = 1 mile for reproduction.	Ditto Topo.
	Cadastral Surveys.				
2	Bengal . . .	34	Captain J. M. Fleming, S.C.	16″ = 1 mile and 4″ = 1 mile for reproduction.	Director, Bengal Surveys.
3	Upper Burma . .	52	Mr. G. B. Scott . . .	16″ = 1 mile for reproduction.	D. S. G., Rev.
4 & 5	Bihar	56	Captain G. B. Hodgson, S.C.	16″ = 1 mile for reproduction.	Director, Bengal Surveys.
6	Assam	64	Mr. E. C. Barrett . / Mr. A. J. Gibson .	16″ = 1 mile for reproduction.	D. S. G., Rev.
7	Lower Burma . .	67	Mr. C. Wood . . .	16″ = 1 mile for reproduction.	Ditto Rev.
8	Orissa	70	Lieutenant R. T. Crichton, S.C. / Mr. R. C. D. Ewing.	16″ = 1 mile for reproduction.	Director, Bengal Surveys.
12	Upper Burma . .	75	Mr. W. H. Patterson . .	16″ = 1 mile for reproduction.	D. S. G., Rev.
Det.	Garhwal . . .	78	Mr. T. F. Freeman . .	32″ = 1 mile and 16″ = 1 mile for reproduction.	Ditto Rev.
	Traverse Surveys.				
9	Central Provinces .	83	Captain W. J. Bythell, R.E.	16″ = 1 mile (skeleton plots).	Ditto Rev.
	Geodetic.				
22	India	85	Captain S. G. Burrard, R.E.	.....	D. S. G., Trig.
23	India	86	Lieutenant G. P. Lenox-Conyngham, R.E.	.....	Ditto Trig.
	Tidal and Levelling Operations.				
25	India	87	Lieutenant-Colonel J. Hill, R.E.	.....	Ditto Trig.
	Geographical Surveys.				
11	Upper Burma . .	90	Colonel R. G. Woodthorpe, C.B., R.E.	¼″ = 1 mile . .	D. S. G., Topo.
21	Ditto . .	91	Captain F. B. Longe, R.E. / Captain T. F. B. Renny-Tailyour, R.E.	¼″ = 1 mile . .	Ditto Topo.

OUTTURN.

8. The aggregate area surveyed in detail during the year amounts to 104,711 square miles. In addition to this, the traverse operations in the Central Provinces, for the purpose of furnishing a basis for field surveys under the Settlement Department, and the skeleton survey of village boundaries in Bengal embrace an area of 3,563 square miles. The following is a summary of the operations of the different field parties in the order in which they appear in the above statement. A detailed report of the work of each party for the year under review will be found in Part II.

TRIGONOMETRICAL SURVEYS.

9. The principal series in Burma, on the meridian of 96° 30′, was extended over a distance of 70 miles, embracing an area of 1,240 square miles, comprising three quadrilateral figures formed by eight stations and reaching the parallel of 23° 30′ north latitude. A secondary series, on the parallel of 21°, commenced in the previous season, was extended over an additional distance of 104 miles, making the whole length from its origin 180 miles. The measurement began a little to the east of Fort Stedman and terminated near the Mekong river. The series embraces in its entire length an area of about 3,200 square miles, comprising 15 stations of observation and lying between the meridians of 96° 30′ and 99° 30′ east longitude.

TOPOGRAPHICAL SURVEYS.

10. Three parties and two detachments have again been employed on this class of operations during the year. The three parties, Nos. 10, 15 and 18, have continued the topographical surveys on various scales in the Bombay Presidency, in Baluchistan, and in the Himalayas, respectively; the Mergui detachment continued the survey of the tin-bearing tracts in that district, and a second detachment was organised for the survey of the Indus river from the Sind-Punjab boundary down to the sea, which was commenced.

11. In addition to the topographical work executed by these parties, a special survey on the 1-inch scale was made of the coal-fields in the Mergui district by No. 7 Cadastral Party; small areas were also surveyed on the 2-inch scale in the Minbu district, by the cadastral party employed there, to complete the topographical sheets. A further small area was surveyed on the 8-inch scale in the gold-fields of the Katha district by No. 3 Cadastral Party.

12. The areas topographically surveyed during the year amount to 10,215 square miles, as against 9,909 square miles in the previous year, with the same number of parties.

The total area is made up as follows:—

4,170	square	miles	surveyed	on	the	½	-inch scale.
2,403	,,	,,	,,	,,	1	,,	,,
3,142	,,	,,	,,	,,	2	,,	,,
475	,,	,,	,,	,,	4	,,	,,
19	,,	,,	,,	,,	6	,,	,,
6	,,	,,	,,	,,	8	,,	,,

FOREST SURVEYS.

13. The four forest survey parties continued their operations in the Central Provinces, the Bombay and Madras Presidencies, and in Lower Burma, and an additional area of forest lands was surveyed by the party working in the Himalayas.

14. In the Central Provinces, the work was confined to the Nimar district, in which the large area of 628 square miles was obtained on the 4-inch scale, and a considerable area was triangulated in advance for next season's detail survey. The classification of forest growth and soils of the area surveyed was also carried out as usual. The large outturn of work, which exceeds that of

last year by 145 square miles, and was obtained in spite of a very unhealthy season, must be considered very satisfactory.

15. In the Bombay Presidency, the work lay in the Central and Southern circles, and comprised surveys on the 16-inch scale in the Poona district, on the 8-inch scale in the Poona and Kolaba districts, and on the 4-inch scale in the Kanara district. The total area surveyed amounts to 426 square miles, or about the same as last year's outturn.

16. In the Madras Presidency, the surveys on the 4-inch scale of the forests in the Madura and Coimbatore districts were continued, and similar operations were commenced in the Salem district. The total area surveyed was 788 square miles, which exceeds that of last year by 129 square miles and is by far the largest outturn yet obtained. This is due to exceptionally good weather enjoyed during the season and to comparatively little sickness. It is satisfactory to note that, with the increased area surveyed, the cost-rate has been correspondingly lowered, being only ₹78 per square mile, or ₹19 less than last year.

17. In Lower Burma, the operations of the previous season in the Toungoo district were continued, and comprised surveys on the 4-inch scale of reserved forests and on the 2-inch scale of the intermediate unreserved tracts. The total outturn was 345 square miles, or 51 square miles in excess of that of last year.

18. In the Himalayas, an area of 100 square miles of forest lands was surveyed on the 4-inch scale by No. 18 Party.

19. The total outturn of forest surveys executed on various scales during the year amounts to 2,170 square miles, which is 75 square miles less than last year, when however, in addition to the outturn of the above parties, a considerable area was obtained by a detachment of the cadastral party working in the Western Duars. The areas on the different scales are as follows :—

113	square miles	surveyed	on	the	2-inch	scale.	
1,850	,,	,,	,,	,,	4	,,	,,
185	,,	,,	,,	,,	8	,,	,,
22	,,	,,	,,	,,	16	,,	,,

CADASTRAL SURVEYS.

20. The number of parties engaged on cadastral operations during the year has been as follows :—Three parties (one of about double strength) in Bengal; three parties in Burma; one party in Assam; and a detachment in the North Western Provinces.

21. In Bengal, the three parties were employed as follows :—One in Bengal proper, one in North Bihar, and one in Orissa.

22. The party (No. 2) working in Bengal proper was divided into eight detachments and employed in various different localities. In Chittagong, the operations were in continuation of those of the previous season, and comprised the cadastral survey of the cultivated lands and a skeleton survey of the village boundaries on the 4-inch scale. The outturn of the former is 159 square miles and of the latter 464 square miles. All the survey work required in this district has now been completed.

In the Burdwan Raj estates, also, the operations of the previous season were continued and consisted of the skeleton survey of the village boundaries which had not been previously measured. The outturn comprises an area of 783 square miles, and the whole of these estates in district Bankura have now been completed.

In the Chakla Roshnabad estate in Tippera, where the preliminary traverse operations had been commenced in the previous season, the cadastral survey and record-writing was undertaken. As the Maharaja of Hill Tippera had requested that the survey should be prolonged over two seasons at least, an area of only 300 square miles was allotted for the year under report. Considerable difficulties were met with, which delayed progress; but the programme was practically carried out, and an area of 293 square miles was surveyed on the 16-inch scale, while the traverse survey of the whole estate was completed.

In the Jaipur Government estates, district Bogra, traverse and cadastral survey operations were commenced by a small detachment transferred from Bankura. The work was much impeded by heavy rain and sickness among the establishment. The area traversed was 60 square miles, of which 13 square

miles were surveyed cadastrally on the 16-inch scale. The record-writing was, at the request of the estate officials, postponed till the next season.

The cadastral survey of the Pataspur estates, district Midnapur, having been ordered by the Government of Bengal, this work was undertaken by a small detachment and completed during the season. It extended over an area of 57 square miles and comprised 18 *zamindáris*.

The survey of the lands reclaimed under the Rajapur drainage scheme, which had been commenced in the previous season under the orders of the Collector of Hooghly, was at his request undertaken by this party and was carried out by a detachment under a pensioned surveyor. The survey was cadastral on the 16-inch scale, and its object was to acertain the area of the lands benefited by the scheme with a view to their re-assessment. The total area, which had been considerably under-estimated, proved to be 84 square miles, of which 76 square miles were traversed and 43 square miles cadastrally surveyed during the season.

In the Palamau Government estate in Chota Nagpur, traverse operations were carried on by a detachment transferred from the Gaya survey. The area to be surveyed in detail amounts to 110 square miles, of which 38 square miles were traversed in advance for next season's detail survey. The work was much delayed by sickness.

In the Tikari Ward's estates, district Gaya, of which the cadastral survey was ordered by the Government of Bengal in April 1893, the work done was also confined to preliminary traverse. The total area of the estates is 550 square miles, of which 171 square miles were traversed during the season.

The aggregate area cadastrally surveyed by this party amounts to 565 square miles and the record-writing was completed of 249 square miles.

23. In Bihar, the cadastral survey and preparation of the record of rights was commenced by No. 4 and 5 Parties in the Muzaffarpur and Champaran districts, where traverse operations had previously been carried out, and preliminary operations were commenced in the Saran district. The outturn of cadastral survey in the first two districts was 945 square miles, and of the record-writing 786 square miles; in Saran, the operations were confined to traverse survey. The total area traversed in the three districts was 2,994 square miles.

In Muzaffarpur, the cadastral survey was mainly carried out by the agency of professional *amins*. In Champaran the work was carried out by *patwáris* or substitutes provided by the *patwáris*; but the number required to complete the full area laid down in the season's programme could not be trained in time, and those who were employed could not be induced to exert themselves and continually absented themselves without leave. The average cost-rates per square mile for the operations in North Bihar are as follows:—Traversing, including demarcation and stone-embedding, ₹34·5; cadastral survey and completion of maps, ₹79·0; record-writing and statistics, ₹60·7. These rates are higher than was expected, which is due to various causes. In the first place, this being the first season of cadastral survey with record of rights, all the extraordinary expenditure involved in moving a party from another locality has fallen into this year's cost. The agency employed was for the most part without sufficient experience; while in Champaran, the very short outturn performed by the *patwáris* tended to largely increase the cost.

24. In Orissa, No. 8 Party continued the operations of the previous season and executed a large amount of work. The cadastral survey, on the 16-inch scale, and the record-writing of the Cuttack district was completed, and similar operations were commenced in Balasore district, while the traverse survey of the latter district was completed. In the Puri district, a revision survey on the 32-inch scale of a few villages of the revenue-free estates belonging to the temple of Jaggarnath was carried out in order to furnish an estimate for the cost of revising the survey of these estates. A survey of Cuttack town was also made on the 64-inch scale. The aggregate outturn in the Orissa division comprised the cadastral survey of an area of 1,577 square miles and the record-writing of 3,656 villages covering an area of 1,873 square miles.

25. In Burma, three parties were employed again this year—one in Lower Burma and two in Upper Burma. In the former, cadastral surveys were executed by No. 7 Party in the districts of Amherst, Tavoy and Mergui, and traverse was carried on in advance in Shwegyin. The outturn in square miles in each of

the districts is as follows:—In Amherst, 688, in Tavoy, 88, and in Mergui, 127 square miles, making a total of 903 square miles of cadastral survey on the 16-inch scale. The advance traverse survey in Shwegyin amounted to 180 square miles. The unusually early commencement of the rainy season, combined with the delays due to the difficulty of transporting the field surveyors from one place to another in such inaccessible countries as Tavoy and Mergui, affected the outturn of work, and rendered it impossible to finish the allotted portions in Mergui, where about 70 square miles of cultivated lands still remain for survey. Those of Tavoy have been finished. In Amherst, all but about 50 square miles of those portions originally assigned for survey have been completed, but in the last six months some 1,000 square miles along the coast and up certain valleys have been added to the programme. The party will thus be fully occupied during the next season in completing the districts of Amherst and Mergui. Employment was given to 50 Burman and Karen field surveyors, of whom 35 only had been enlisted under Mr. Bridges' scheme, which was introduced in 1886 with the object of inducing Burmans to remain with the survey party—*vide* paragraph 197 of the General Report of the operations of the Survey Department for 1886-87. The average outturn of these Burman surveyors proved to be two-thirds that of the imported *amin*, which is a slight improvement on the work of former years; but still the cost of surveys executed by Burman field surveyors is greater than that by *amins* imported from India, even after allowing for the expense of importing the men from India. It has been proposed to introduce a scheme very similar to and with the same object as that devised by Mr. Bridges above alluded to, both in Lower and Upper Burma. The main difference between the two consists in the term of service being reduced from five years to two years.

26. One of the two parties in Upper Burma (No. 3 Party) was employed mainly on the continuation of the cadastral survey of the Shwebo district and the commencement of that of Yeu district. In addition to this, however, a small portion of the boundary between Manipur and Burma near Kongal thana was relaid, and the survey and demarcation of certain blocks in the Katha district, in which gold-mining rights were to be granted, were executed. The total outturn of cadastral survey amounted to 1,766 square miles, of which 1,599 were in Shwebo and the remaining 207 in Yeu. The area of the 15 blocks surveyed on the 8-inch scale in Katha aggregated six square miles: all those employed on this work in Katha suffered severely from malarious fever. Local labour was still more largely employed this year, and only 500 *khalásis* were imported from India in place of 900 in 1889. This represents in passage-money alone a saving of ₹12,000. But few men belonging to the districts under survey came forward for employment as field surveyors.

27. The other party in Upper Burma (No. 12 Party) was engaged in the cadastral survey of the Minbu and Magwe districts, that of the former being now completed. The areas surveyed amount to 491 square miles in Minbu and 750 in Magwe; in addition to these an area of 12 square miles was completed in Myingyan, making a total of 1,253 square miles surveyed, of which 25 square miles, being hilly and uncultivated, were made on the 2-inch scale. Advance traverse work was carried on in Magwe. Fifty Burman field surveyors were employed, and 95 *amins* were imported from India. The outturn of the Burmans is 336 square miles against 917 by the Indian *amins*, which gives about the same result as in the party in Lower Burma, *viz.*, that the Burman field surveyor can survey about two-thirds the area that an Indian *amin* can do in the same time. These 50 Burmans were mostly men from Lower Burma, not men of the districts under survey. A considerable amount of local menial labour was again utilised in both districts.

28. Those portions of the Assam Valley of which a cadastral survey was required having been completed, the party was transferred to Sylhet and employed in surveying the Jaintia *parganas*, where about 300 square miles had been traversed during 1891-92. The whole of the *parganas*, occupying an area of 484 square miles, was completed, including both the survey and the writing of the village records. The field survey establishment was a mixed one, consisting partly of imported *amins* and partly of local men trained during the season. A survey of the town of Gauhati was also made on the 32-inch scale. The revision of the previous season's work in the Assam Valley was carried out under

the superintendence of the Settlement Department. During 1893-94 the party will be employed in the traverse and cadastral survey of part of Cachar and in the revision survey of the Jaintia *parganas*.

29. The detachment in the North-Western Provinces was employed in the continuation of the cadastral survey of Garhwal, which is being made on the 32-inch scale on account of the very small size of the fields. In consequence of an outbreak of cholera during the previous year, hardships due to the inclement climate in the higher parts of the district, and the high price of provisions, many of the Hindustani *amins* from the plains refused to return, and nearly three-fourths of the field establishment consisted of local hill-men. Of these, a considerable number had received training during the two previous seasons, and so no serious difficulty was caused by the defection of the men from the plains. These hill-men work sufficiently accurately; but their maps are sent in in a very dirty condition, and they are very apt to absent themselves and go to their homes on trivial pretexts. The area surveyed amounted to 270 square miles, of which 166 will be classified as assessable land, whilst at the time of the last settlement only 56 square miles were assessed. The outturn is a slight increase on that of last year, and it would have been still greater had it not been for the unusually severe winter and heavy falls of snow; the scattered nature of the work also retarded progress. The cost-rate per square mile of the detail survey, including writing the record, is ₹167, which is a still further reduction on that of last year, which was ₹183. The reduction is due to the larger number of local men employed and to their increased skill and experience.

30. The areas of cadastral survey completed during the year in the different provinces are as follows:—

	Square miles.
Bengal	3,087
Burma	3,896
Assam	484
North-Western Provinces	288
TOTAL	7,755

This outturn shows an increase of 1,157 square miles over that of last year, when the number of parties at work was the same.

TRAVERSE SURVEYS.

31. One party was again employed this year on traverse operations in the Central Provinces, where a portion of the district Balaghat was still incomplete; and in addition to this skeleton plots of a certain number of villages in the *zamindári* estates of the Raipur, Bilaspur, and Sambalpur districts were required by the Settlement Department. Owing to the extremely scattered nature of the work, which necessitated the running of a number of extra sub-circuits to connect the isolated villages, the area of work reported as completed is considerably less than those of previous seasons, although the labour involved is very nearly the same, which is proved by a comparison of the number of stations fixed. An abnormally heavy rainfall during the months of March and April considerably retarded the progress of the work and still further tended to reduce the outturn. The area traversed amounts to 879 square miles in Raipur, 740 square miles in Bilaspur, 526 square miles in Sambalpur, and 171 square miles in Balaghat, making a total of 2,316 square miles altogether.

32. In Bengal, two detachments of No. 2 Party executed skeleton surveys of village boundaries in the Chittagong and Bankura districts, as described under the head of cadastral surveys, and completed an aggregate area of 1,247 square miles.

33. The total areas which have been traversed during the year, in addition to the preliminary traversing connected with the cadastral surveys, are as follows:—

	Square miles.
Central Provinces	2,316
Bengal	1,247
TOTAL	3,563

SPECIAL OPERATIONS.

34. The two astronomical parties under Captain Burrard and Lieutenant Lenox-Conyngham were employed in observing latitudes. The former officer worked northwards along the meridian of 72° 30′, between the parallels of 23° and 27° 30′ north latitude, and completed observations at eight stations. The latter was employed along the Bombay Longitudinal Series, on the parallel of 18°, in which observations were taken at seven stations between the meridians of 73° and 78°, in addition to two stations in Dehra Dun at the foot of the Himalayas.

35. The tidal operations have been continued as usual. Observations with the self-registering tide gauges have been made at fourteen stations in India, Burma, the Persian Gulf, Ceylon, the Andaman Islands, and Minicoy. One observatory has been dismantled during the year under report and two new ones opened, *viz.*, at Muscat and Bushire. Three others are expected to be ready for working shortly, *viz.*, at Diamond Island, Port Albert Victor, and Madras, while in January and March 1894 those at Bhavnagar and Mergui will be closed.

36. In connection with these operations, spirit-levelling was carried on from Elephant Point to Mandalay *vid* Rangoon along the railway line. The season's operations consist of 464½ miles of double levelling, fixing one standard, 431 permanent, 54 Railway, three Public Works Department, and three Revenue Survey bench-marks, and determining the values of six stations of the Great Trigonometrical Survey. In addition to the above, a spirit-levelling connection was made between the tidal observatory and the base line at Mergui.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

37. There has been a considerable increase in the area geographically surveyed during the year, which is due to the very large tract of country, nearly 50,000 square miles in extent, mapped by the surveyors employed on reconnaissance work in the Helmand desert, Sistan, and Perso-Baluchistan. The areas mapped in Upper Burma are much smaller than in previous years, owing to the fact that but little work of this class now remains which can be undertaken without special protective measures.

38. Of the two parties, Nos. 11 and 21, employed in Upper Burma, the former was unable to undertake any regular survey, as the greater part of the establishment was required to accompany the Burma-Siam Boundary Commission, while the remaining section was rendered ineffective by the death of the Assistant in charge just as it was proceeding to the field. The party with the Boundary Commission succeeded in mapping a large area of new country in Kengtung and in Siamese territory, amounting to 5,853 square miles, on the ¼-inch scale and 165 square miles on the ½-inch scale, besides executing a considerable area of triangulation and traverse work. No. 21 Party was engaged in more regular work, and secured a very satisfactory outturn of 17,982 square miles, mapped on the ¼-inch scale, in the Northern Shan States, and the Katha, Bhamo, and Upper Chindwin districts. The outturn would have been larger still but for a rising of the Kachin tribes north-east of Lashio, which however was suppressed with praiseworthy promptitude by Mr. Kennedy, Sub-Assistant Superintendent, who was engaged in survey operations there.

39. The total areas mapped on the ¼-inch scale in Upper Burma and Siamese territory amount to 23,835 square miles.

40. The geographical work carried out by the party in Baluchistan consists chiefly of the detailed reconnaissance of routes through the Helmand desert, Sistan and Perso-Baluchistan, referred to above. The reports of the surveyors employed on this duty have been separately published. The area mapped on the ¼-inch scale in connection therewith amounts to 49,420 square miles. A further area of 3,700 square miles was mapped on the same scale by this party in Makran.

41. The aggregate areas geographically surveyed during the year amount to 83,955 square miles.

HEAD-QUARTER'S OFFICES.

42. The details of the work done in the various offices at head-quarters are given in Part III of this report.

43. These offices were, as usual, supervised by three Assistant Surveyor-Generals. The Drawing and Engraving Offices continued in the charge of Colonel W. H. Wilkins, S.C., except during the period of five-and-a-half months while that officer held temporary charge of the Correspondence and Mathematical Instrument Offices in the absence on furlough of the permanent incumbent. During this period the charge was held at different times by Major R. A. Wahab, R.E., Mr. T. A. Pope, and Captain C. F. Close, R.E. The Photographic and Lithographic Office remained in the charge of Colonel J. Waterhouse, S.C., except for a period of two months while he was absent on privilege leave, when the charge devolved upon Mr. T. A. Pope. Colonel M. W. Rogers, R.E., continued in charge of the Correspondence and Mathematical Offices, except for the period of his absence on furlough, when Colonel Wilkins officiated for him, as stated above.

44. In the Drawing Office, the principal work of the year has again been the preparation of maps of Burma on various scales. The 16-mile map of Upper Burma was completed, and a map of Indo-China on the 32-mile scale was compiled and was nearly ready for publication at the close of the year. The third edition of the 32-mile map of India, though ready, could not be published for want of orders regarding frontier boundaries. The work of the office increases, and the regular departmental work has still to be put aside in order that the pressing demands for extra-departmental maps of all kinds may receive attention. An increase to the establishment of the office was sanctioned during the previous year, but it has not yet been brought up to the full strength owing to the difficulty of finding qualified draftsmen to fill the vacancies.

45. In the Engraving Office, the six plates of the skeleton 32-mile map of India were completed as far as possible, and those of the 128 and 256-mile maps of India were nearly completed. Maps of the Bombay and Madras Presidencies on the 16-mile scale were commenced, and progress was made with other provincial maps on this scale. The year's work also includes a new chart of the Great Trigonometrical Survey on the 96-mile scale, engraved to replace the old one, which was much worn, a map of Darjeeling on the 4-mile scale, and 16 district maps for administration reports. A large increase of work is reported in the Copper-plate Printing Section, owing to the addition of a new press for dry printing.

46. In the Calcutta City Survey Office, the work of the year comprised the bringing up to date of the original field sheets in respect of new buildings, roads, etc.; 151 sheets were finally examined and sent to press, including the whole of the south division, with Hastings, the maidan, and about half the North Division. The final demarcation of all the holdings of which the boundaries had been left unadjusted at the close of the previous year was also completed. A reduced map of Calcutta on the 16-inch scale will now be engraved by hand with the aid of reduced photo-transfers from the original sheets, and it is expected that the map will be ready in about a year's time.

47. The long pending re-organisation of the Photographic and Lithographic Office was sanctioned by the Secretary of State for India, and took effect from the 8th March 1893. It was very much needed in order to put the combined establishment on an efficient working footing, as well as to provide a proper staff for working the steam machinery, and has been followed by an unprecedentedly large outturn of work in all sections, the increase in the value of the work turned out during the year being nearly ₹38,500 more than last year, while the extra cost of establishment for the period March to September 1893, during which the new scheme was in force, was only about ₹5,201.

48. The outturn of the lithographic and zincographic presses and machines was for the first time over a million pulls—1,026,682—of which no less than 270,614 is increase over the former year. The starting of the new quad-crown steam litho. machine contributed very largely to this increased outturn, which would have been quite impossible without it. The total number of original maps and drawings received for reproduction was 8,365, of which 1,095 were departmental, 5,597 were cadastral maps of the North-Western Provinces, Assam and Burma, and 1,673 were miscellaneous subjects for other departments. As usual, the printed outturn of extra-departmental subjects was very greatly in excess of the departmental work, and the value of it was

R91,118, or about R18,440 more than last year. The total number of pulls of maps, etc., printed off was 1,026,682, besides 1,418,607 impressions from type, 61,082 heliogravure prints, and 1,269 photographic prints The total value of the work was about R248,850, being nearly R38,494 more than last year.

49. The publication of the new third edition of the 32-mile map of India has again been delayed by the non-receipt of orders regarding boundaries. The second edition of the map of Burma and adjacent countries on the 32 and 48-mile scales has been published; also reprints of several provincial maps with revisions to date. The new publications also include maps of the Fyzabad and Lucknow divisions on the 4-mile scale; maps of districts Rajshahi, Burdwan, Birbhum, Bogra, Dinajpur, Balasore, and Purnea on the same scale; 89 standard sheets of the topographical and revenue surveys; a plan of Taunggyi civil station; 41 sheets of the Madras forest survey, and 4 sheets of the Aden survey. The reproduction by photo-zincography of the full scale sheets of the new survey of Calcutta made good progress, though only 30 sheets had been printed off at the end of the year.

50. The extra-departmental work continues to increase steadily, especially in the case of weather charts and plates for the illustration of the meteorological reports for India and Bengal; also for plans and drawings of railway stock, etc., for the Director-General of Railways and the Public Works Department, India. Besides the geological and coal and iron maps of India noticed in last year's report, which were completed and printed off, a new edition of the forest reserve map of India, on the 48-mile scale, was lithographed and printed in three colours. Maps of the Fyzabad and Benares divisions were completed and printed. A series of plates illustrating the report of the archæological remains in the Kistna district were photo-zincographed or photo-lithographed and printed off. A much more extensive series of similar plates illustrating the architecture of Fatehpur-Sikri is in hand.

51. Increasing use is being made of heliogravure; 85 plates were reproduced by photo-etching, including 21 of the Bower Manuscript, four plates of crustacea for the Indian Museum, seven plates illustrating Captain Bower's report on his travels in Tibet, and 12 plates of the Technical Art Series. A specimen of the work done by this process is given as a frontispiece, being a reproduction from a negative by Major Gore, R.E., representing the Shainsar temple in Kulu. Eighty photo-blocks were prepared for the illustration of Mr. Cotes' papers on Economic Entomology. A trial was made of a new method of reproducing maps in colour by heliogravure, of which a specimen will be found at page 108 of this report. Trials have also been made of a method of correcting engraved copper-plates by the electro-deposition of copper, which was first introduced by Colonel Waterhouse about 20 years ago. The method is of particular value in enabling corrections to be made with less damage to the surrounding work than is the case with the ordinary method of beating up, but difficulties are still found in the practical working of it which require further experience to overcome.

52. The number of new maps and new editions of departmental subjects published during the year amounted to 5,645, of which 5,426 were cadastral maps. The total number of maps issued was 323,263, and their value R1,50,974. These figures show a large increase over those of last year, the excess being in the number of general maps issued to Government officials, which is four times as great as last year. The cash sales of maps amounted to R33,303 during the year against R22,091 last year.

53. The demands on the Mathematical Instrument Office for scientific instruments was again in excess of last year. The total number of instruments issued was 100,527 as compared with 83,202 last year. The total value of these instruments was however less, being R2,97,150 as compared with R3,16 373 last year.

During the year 108,654 serviceable instruments, valued at R2,77,820, and 3,054 repairable instruments, valued at R49,021, have been received into store. The system of cash payments for supplies not exceeding the value of R50 has now been extended to all departments of Government, and in consequence the cash receipts have increased from R23,137 in the previous year to R28,186 in the present year.

54. In the Trigonometrical Branch Office at Dehra Dun, the Computing Section has completed the final reduction of all the electro-telegraphic arcs of longitude within the limits of India proper. The volume containing the reduction, No. 15 of the series of the Account of the operations of the Great Trigonometrical Survey of India, has been printed and published, and will shortly be distributed. A small catalogue of stars, based upon the observations for latitude and longitude that have been accumulating for many years, has been compiled and published. Five synoptical volumes have been published and three more are nearly ready. Good progress has been made with the volume containing the tidal observations, and a pamphlet of spirit-levelled heights, No. 7, Bombay Presidency, has been issued. Photographs of the sun were, as usual, taken on all days when it was visible, and the negatives forwarded to the Solar Physics Committee at South Kensington.

55. The Simla Drawing Office has been principally engaged on the sheets of the North-West and Northern Trans-frontier. New editions of the maps of Turkestan and Baluchistan were brought near completion, and a new map of Afghanistan was commenced. In addition, a large amount of miscellaneous work was done, including Captain Bower's route map through Tibet and Lieutenant Swayne's map of the Somali country.

ESTABLISHMENT.

56. During the year a scheme for the re-organisation of the junior division, with the object of improving the pay and prospects of the officers therein, has received the sanction of the Government of India and the Secretary of State.

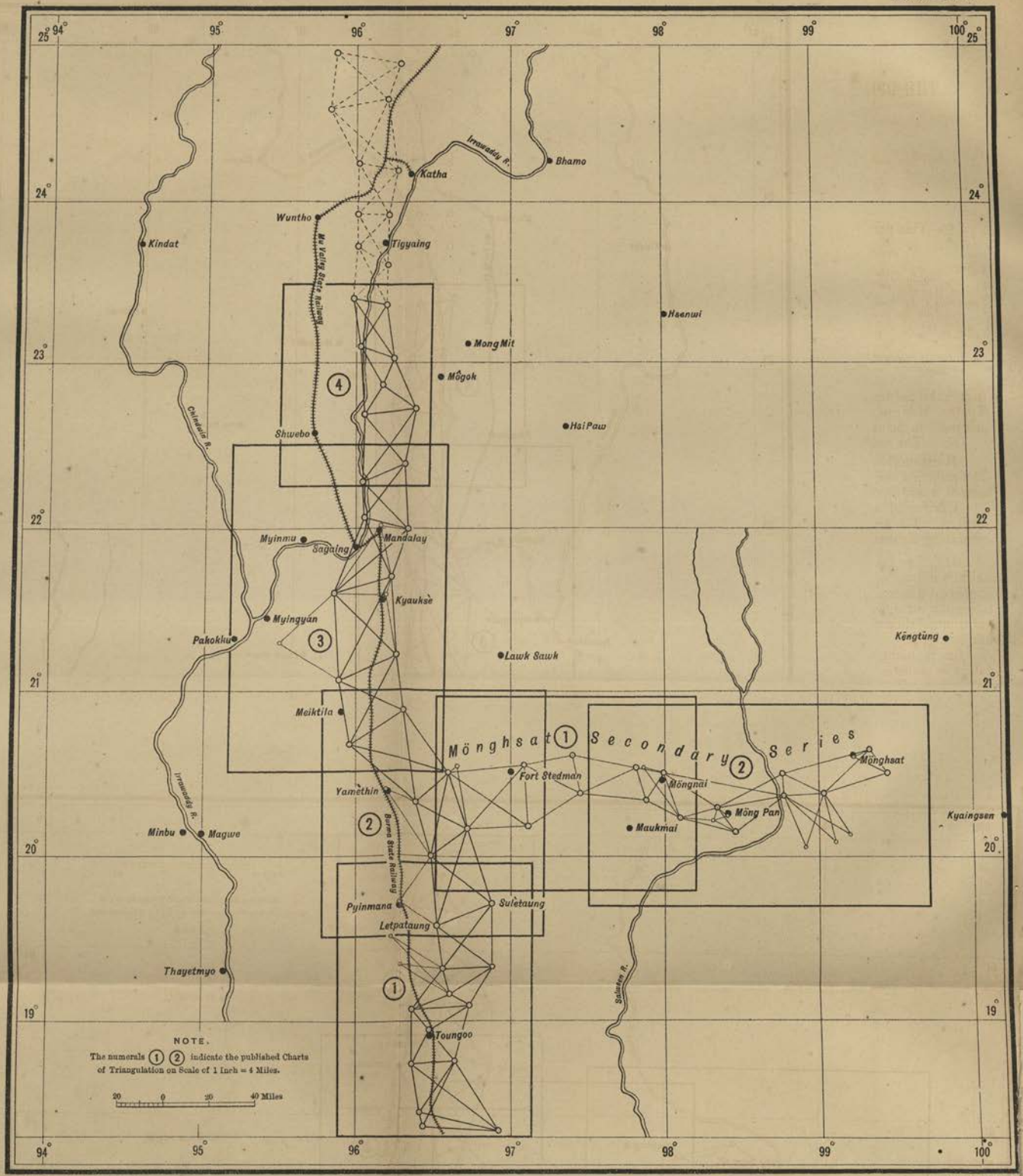
Under this scheme two additional grades, one on ₹550 and one on ₹450 per mensem, have been created in the upper class of Extra Assistants, and the number of officers in this class has been increased from 50 to 60. In the lower class of Sub-Assistant Superintendents the number has been reduced from 81 to 72, and the numbers in the grades in both classes have been re-adjusted. The whole re-arrangement has had the effect of giving considerable promotion to the more senior officers, while it is expected to secure to the junior division generally a regular flow of promotion in future. The extra expenditure involved has been more than met by a net reduction of two officers in the senior division—a measure which was rendered possible by the abolition of a field party and by the arrangements effected in Bengal of forming four field parties into two double parties, requiring two Deputy Superintendents instead of four.

57. In the senior division one officer only has left the Department during the year, *viz.*, Mr. W. H. Patterson, who was superannuated on the 24th September 1893 after a service of nearly 42 years in the Department, of which 32 years were passed in the junior division.

58. In the junior division seven vacancies occurred—four by the deaths of Messrs. F. Kitchen, E. Graham, E. J. Martin, and H. T. Kitchen; one by the retirement of Mr. B. M. Wilson; one by the deputation of Mr. J. H. O'Donel to the Assam Government; and one by the promotion of Mr. G. W. E. Atkinson to the senior division. Shortly after the close of the year, report was received of the death of Mr. A. Kitchen, the youngest brother of Messrs. F. and H. T. Kitchen, who had died only a few months previously, and thus within the space of 12 months three brothers, who had each rendered meritorious service of over 20 years, were cut off in the prime of life.

INDEX TO THE CHARTS OF THE PRINCIPAL TRIANGULATION
OF THE
MANDALAY MERIDIONAL AND MÖNGHSAT SECONDARY SERIES, BURMA.

No. 24 PARTY.



Reg. No. 644, S. I. D.—Nov. 93.—500.

Photo., S. I. O., Calcutta.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

PRINCIPAL TRIANGULATION.

BURMA.

No. 24 Party.

59. This party, under Captain Close, continued the principal triangulation in Upper Burma northward from the side Sheinmaga-Sanwintaung, up to which it had been carried in the previous season; it also executed a secondary series, starting from the principal stations Lethataung-Sintaung, stretching due east through Möngnai to Mönghsat, to fix points on the Siamese boundary. The principal triangulation was carried through the Mandalay, Ruby Mines, and Shwebo districts; the secondary triangulation through the Shan States of Nyaungywi, Thaton, Möngsit, Möngnai, Möng Pan, Möngtúng and part of Kengtúng, with one point in Siam and three on the boundary.

Personnel.

Captain C. F. Close, R.E., Officiating Deputy Superintendent, 2nd grade, in charge to 6th May 1893.
Lieutenant J. M. Burn, R.E., Assistant Superintendent, 1st grade, in charge from 6th May 1893.
Mr. T. H. Rendell, Extra Assistant Superintendent, 3rd grade.
„ J. Hickie, Extra Assistant Superintendent, 4th grade.

60. The season's outturn is as follows:—

Horizontal and vertical angles have been taken at eight principal stations. The principal series was extended over a distance of 70 miles, embracing an area of 1,260 square miles.

Horizontal and vertical angles have been taken at thirteen secondary stations. The secondary series was extended over a distance of 180 miles, embracing an area of 3,200 square miles.

61. The principal observations were taken with Troughton and Simm's 12-inch microscope theodolite No. I, the method of observing being to measure angles on 9 zeros, two faces on each zero, two swings on each face, The mean triangular error, which ranged between 1″·000 and 0″·028, is 0″·40. The principal triangulation of three figures has been adjusted, *viz.*, two quadrilaterals and one tetragon.

62. A comparison of the trigonometrical heights with the final levelled values at some of the principal stations of the Mandalay Meridional Series is interesting. The greatest error of 11·5 feet is at Yamethin S., and, considering that the trigonometrical series is in continuation of a chain extending over 800 miles without any check, the result is satisfactory. The following table shows the differences of height obtained:—

Name of Station.	Height above sea-level in feet.		Difference feet.
	By triangulation.	By spirit levelling.	
Myayabengkyo H. S.	1,411·1	1,407·0	+ 4·1
Toungoo S.	185·7	176·1	+ 9·6
Pyinmana S.	429·0	418·6	+10·4
Yamethin S.	708·5	697·0	+11·5
Taungpila H. S	1,011·5	1,005·2	+ 6·3
Mandalay H. S	785·4	774·4	+11·0

63. The secondary observations with the 14-inch Vernier theodolite were taken on 2 zeros, those with the 12-inch microscope theodolite on 2 zeros, and those with the 10-inch Vernier theodolite on 3 zeros. The mean triangular error was 1″9.

64. Captain Close spent some days at the end of the season in setting up and adjusting a transit instrument at Rangoon Observatory at the request of the Port authorities there.

65. The party left Mandalay for recess quarters at Mussooree on dates varying between 7th April and 6th May under the charge of Lieutenant Burn, Captain Close having been transferred to another party at the close of the field season.

66. The health of the party in the Southern Shan States was not very good.

67. A statement giving the details of the outturn executed during the year will be found at page i of the appendix.

68. During recess the party was working under the orders of Lieutenant J. M. Burn, in the office of the Deputy-Surveyor-General, Trigonometrical Branch, who inspected the party in October and reports favourably thereon.*

TOPOGRAPHICAL SURVEYS.

SOUTHERN MARATHA COUNTRY.

No. 10 Party.

69. This party remained in the charge of Major J. R. Hobday throughout the year, and continued the survey on the 2-inch scale of the Southern Maratha country and portions of Ratnagiri district in the Konkan below the *ghats*. The party took the field about 15th November 1892, and returned to recess quarters at Poona on 5th June 1893.

Personnel.

Major J. R. Hobday, S.C., Deputy Superintendent, 1st grade, in charge.
Lieutenant H. A. Denholm Fraser, R.E., Officiating Assistant Superintendent, 1st grade.
Mr. W. Todd, Extra Assistant Superintendent, 1st grade.
Mr. W. Stotesbury, Extra Assistant Superintendent, 3rd grade.
Mr. C. E. Tapsell, Extra Assistant Superintendent, 5th grade.
Mr. R. R. Dickinson, Extra Assistant Superintendent, 6th grade.
Mr. G. A. Knight, Extra Assistant Superintendent, 6th grade.
Mr. J. A. Freeman, Sub-Assistant Superintendent, 3rd grade.
36 surveyors, sub-surveyors and others.

70. The detail survey of sheets Nos. 174, 175, 206, 207, 241, 242, and 303 was completed, whilst triangulation in advance was effected in sheets Nos. 308, 309, 310, 311, 334, 335, 336, and 337 in the Dharwar district, and in sheets Nos. 176, 208, and 209 in the Ratnagiri district and Native States of Kolhapur and Savantvadi.

The traversing of the tri-junctions of village boundaries in British territory was carried on in sheets Nos. 174, 175, 206, 207, and 303; also in portions of sheets Nos. 308 and 309 in advance.

71. The total outturn of the season's work is as follows:—

Triangulation	3,550	square miles.
Traversing	1,351	linear ,,
Topography, 2-inch scale	2,778	square ,,

The accuracy of the survey was checked by 294·8 linear miles of test traverse in addition to *in situ* examinations.

72. Clinometer heights were obtained in the proportion of from 4 to 6 per square mile in hilly country to facilitate the delineation of approximate contours at 50 feet vertical intervals apart and to assimilate the hill drawing of the different surveyors. The introduction of system in this matter has considerably improved the hill drawing powers of the surveyors, and thereby enhanced the value of their work without lessening their daily rate of progress in the field.

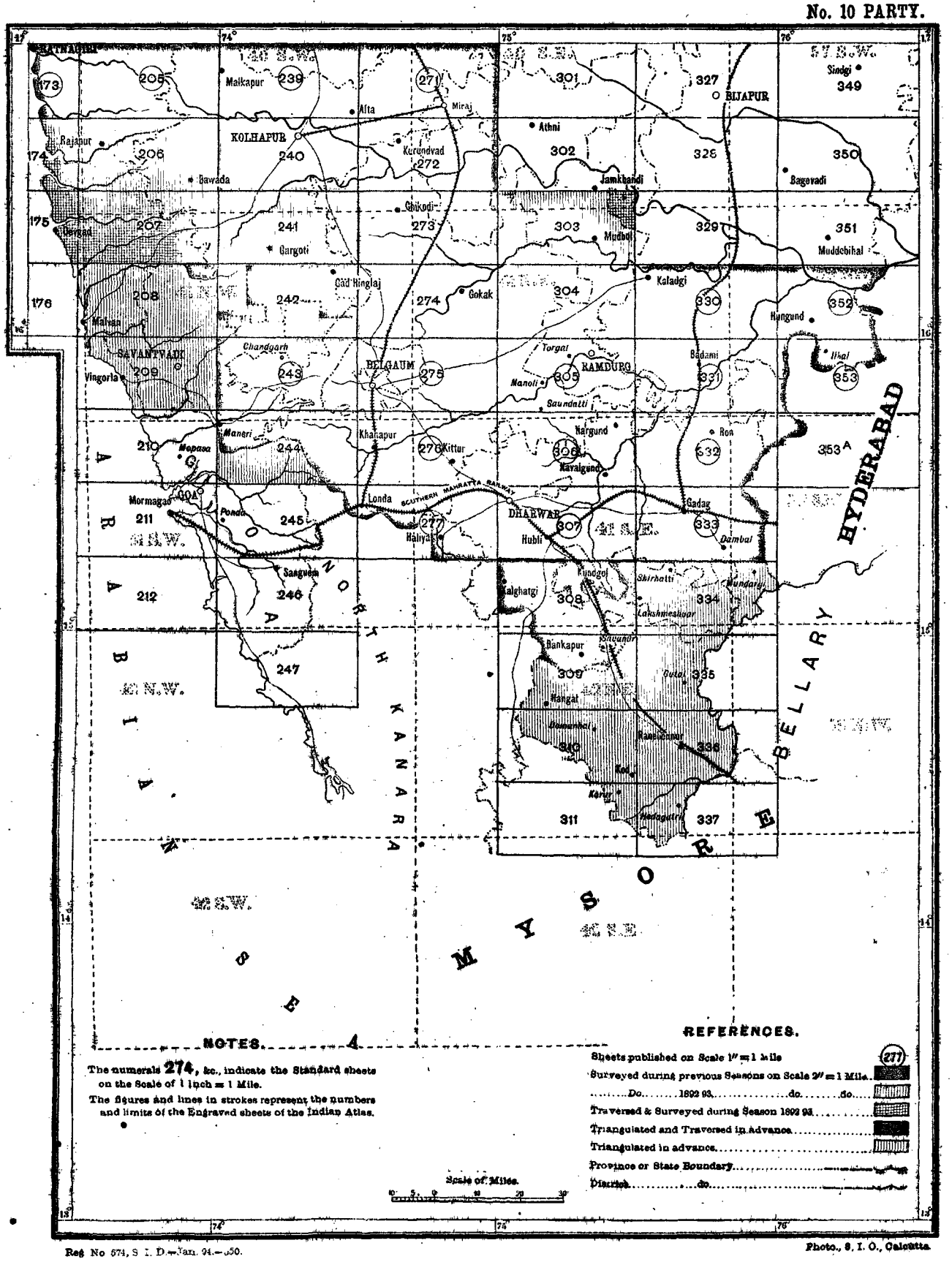
73. The character of the country surveyed is open and easy, except in the vicinity of the *ghats* where the forest is occasionally heavy. The health of

* Captain Close speaks in high terms of the work done by every member of the party, with the exception of one surveyor.

BOMBAY SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN SOUTHERN MARATHA COUNTRY.

No. 10 PARTY.



NOTES.

The numerals **274**, &c., indicate the Standard sheets on the Scale of 1 inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

REFERENCES.

- Sheets published on Scale 1" = 1 Mile (277)
- Surveyed during previous Seasons on Scale 2" = 1 Mile
- ....Do.... 1892 93 ....do.... do....
- Traversed & Surveyed during Season 1892 93
- Triangulated and Traversed in Advance
- Triangulated in advance
- Province or State Boundary
- District ....do....

Reg No 674, S. I. D.—Jan. 94.—350.

Photo., S. I. O., Calcutta.

No. 224-S. 94.

the party remained excellent throughout, notwithstanding the great heat experienced in the Konkan, below the *ghats*, towards the close of the season.

74. It having been ascertained from the Settlement and Survey Commissioner that the numerical values of the tri-junctions of villages, and of intermediate stations, in those parts of the country remaining for survey in British territory are no longer required, and will never be utilised by the Bombay Revenue Survey, orders have been issued to stop this work and to transfer the traverse surveyors to other parties where their services can be utilised. The tri-junctions of villages will in future be fixed topographically on the field sheets, and the village boundaries obtained from the Revenue Survey maps will be shown, as at present, on the 1-inch standard maps.

75. Considerable progress has been made in the compilation of the Gujarat General Reports. It is estimated that this work will be completed during the year 1894.

76. The programme for next field season consists of the detail survey on the 2-inch scale of sheets Nos. 208 and 209 (omitting a small portion of Goanese territory), 334 and 335, and those portions of Nos. 308 and 309 falling in Dharwar, with extensions, if possible, into sheets Nos. 310, 311, 336, and 337; also the survey of Belgaum city and cantonment on the 8-inch scale should this be required by the Civil and Military authorities. There will also be two camps carrying on triangulation in advance.

77. Lieutenant Fraser, R.E., triangulated an area of 2,500 square miles in the Dharwar district, during this his second season, in a most creditable manner; he has now therefore received instruction in all the usual field and office operations connected with a topographical survey. He is a most promising young officer.

78. The recess office of this party was inspected by the Surveyor-General in September 1893, who was well satisfied with the character of the field work, in which considerable improvement has been made of recent years. The computation and mapping were well advanced and the records systematically kept. The drawing of the topographical maps of this party is excellent.*

BALUCHISTAN.

No. 15 Party.

79. The operations on which the party was employed during the season were—

(1) a detailed reconnaissance of routes through the Helmand desert, Sistan, and Persian-Baluchistan.

(2) Triangulation, including—
- (*a*) extension into Eastern Persia;
- (*b*) Zhob Valley Series;
- (*c*) settlement survey.

(3) Topography, including—
- (*a*) settlement surveys on the 16-inch scale;
- (*b*) special surveys on the 6-inch scale;
- (*c*) surveys in Bela district and Lower Zhob on the $\frac{1}{2}$-inch scale;
- (*d*) surveys in Makran on the $\frac{1}{4}$-inch scale.

Personnel.

Colonel T. H. Holdich, R.E., Superintendent, 1st grade, in charge.
Captain R. J. H. L. Mackenzie, R.E., Deputy Superintendent, 2nd grade.
Mr. T. E. M. Claudius, Extra Assistant Superintendent, 3rd grade.
Mr. E. A. Wainwright, Extra Assistant Superintendent, 4th grade.
Mr. H. T. Kitchen, Extra Assistant Superintendent, 4th grade.
Mr. G. P. Tate, Sub-Assistant Superintendent, 1st grade.
Yusaf Sharif, Khan Bahadur, Sub-Assistant Superintendent, 2nd grade.
Hira Singh, Rai Bahadur, Sub-Assistant Superintendent, 2nd grade.
Imam Sharif, Khan Bahadur, Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Ahmed Ali, K.B., Abdul Guffar, K.S., Hussein Baksh, Sheik Mohiuddin, Gopal Singh, Asghar Ali, Jaffar Ali, Mohammed Naki, Nizamuddin, and seven others.

80. Quetta was retained as the headquarters of the party during the field season, partly because of the settlement and special survey work which was being carried on in the immediate neighbourhood, and

* Major Hobday brings especially to notice the thorough and painstaking manner in which Mr. W. Todd has carried on the compilation of the Gujarat records; of Messrs Stotesbury and Tapsell, who supervised the detail survey in the field, he speaks highly; and he adds that Messrs. Dickinson, Knight, and Freeman all worked steadily and well, both in the field and in recess. With one or two exceptions the sub-surveyors all worked well.

partly because of the necessity for continuing mapping work through the winter months.

81. The reconnaissance through the Helmand desert, Sistan, and Perso-Baluchistan was entrusted to Mr. E. A. Wainwright, who was assisted by Ahmed Ali, K. B., and Atma Ram in Perso-Baluchistan, and to Surveyor Sheikh Mohiuddin in the Desert country and Sistan. Their work forms the subject of a separate report. The outturn of Mr. Wainwright's section was—

	Square miles.
Triangulation	24,680
Topography, ½-inch scale	49,420

82. Yusaf Sharif, Khan Bahadur, assisted by Jamaldin, took an active share in Persian coast surveying. His triangulation was started on an independent base, measured by himself, with longitude values deduced telegraphically with Kurrachee and latitude and azimuths from astronomical observations. His first base was measured at Charbar and his second at Bandar Abbas. His outturn was—

	Square miles.
Triangulation	17,680
Topography, ½-inch scale	2,500

all of which was eventually connected with Mr. Wainwright's reconnaissance.

83. The extension of triangulation into the Zhob Valley was entrusted to Captain Mackenzie, R.E., who was assisted, during the continuance of the Wana Expedition to which he was attached, by Hira Singh, Rai Bahadur, and Gopal Singh. During the severe weather of the mid-winter months Captain Mackenzie visited and inspected the topographical party in the Bela district, and again returned to the Zhob work in the spring, continuing his observations till July 1893. The outturn of his section was—

	Square miles.
Triangulation	2,000
Topography, ½-inch scale	820

84. Messrs. Claudius and Tate took active charge of the special surveys near Quetta and the settlement surveys in Peshin, as well as of the Head-Quarters Office at Quetta and the mapping which was there carried on during the winter. Hira Singh, Rai Bahadur, was attached to this section on return from sick leave after the Wana Expedition, and he as well as Mr. Tate have been almost exclusively employed on the settlement survey ever since. No special report of this work has been submitted, as it consists chiefly of traversing the *mauzas* within the limits of triangulated points and of projecting the fixed points to serve as a basis for the *patwáris* (who are entertained by the Civil authorities) to fill in the interior details.

85. Mr. H. Kitchen was placed in charge of the ½-inch topography of the Lower Bela district. The country near the coast is comparatively open, but it is very rough to the northward. Water is scarce and bad as the spring advances, and there is great difficulty in keeping up communications in the hill districts. The season was a late one and the heat became excessive long before the party was withdrawn. Mr. Kitchen never recovered from the effects of the field season's work, and died at Quetta on 5th July 1893. The outturn of his section was—

	Square miles.
Topography, ½-inch scale	3,755

86. Little mention has been made of Mr. Graham's work during the season under review, as he had hardly rejoined the party from duty with the Aden detachment when he fell ill. He finally succumbed to pneumonia on the 30th December 1892.

87. A requisition having been made by the Military authorities for surveyors in the Gilgit Agency, two native assistants, Abdul Guffar, K.S., and Atma Ram, were deputed in May 1893 to proceed to Gilgit, and there to report themselves to the local Political Officers for survey duty. No detailed report of the outturn of topography that they may have effected has yet reached India. Abdul Guffar had been previously employed on the regular ½-inch survey of Makran, finally completing the survey of that country. His outturn there was—

	Square miles.
Topography, ½-inch scale	700

88. Two native surveyors, Hussein Buksh and Mohammad Ali, were attached to a political party on tour through the outlying districts of Zhob and Kundar. They brought back with them 4,500 square miles of completed reconnaissance on the ½-inch scale, much of which is sound survey.

89. The courtesy of the Persian Gulf Telegraph officials again enabled Colonel Holdich, R.E., to visit the Makran and Persian coasts and to make personal arrangements with the local Political Officers, as well as to carry out some interesting experiments, which may serve to decide the value of the cable as a means of transmitting time signals for longitude determinations. The general result of the longitude work executed in connection with the Persian telegraph system has been reported on elsewhere. Colonel Holdich, R.E, has submitted a general report on the present state of trans-frontier surveys, which includes an analysis of the value of the coast triangulation: this will be a useful guide to future operations.

90. The field season closed with the return of the last surveyor from the field early in May 1893. The health of the party was, perhaps, exceptionally bad. In addition to the loss of two good assistants in Messrs. Kitchen and Graham, there has been constant sickness throughout the year, necessitating much leave and resulting in great loss of working power. Quetta has not proved a satisfactory sanitarium for men returning from work in fever-stricken districts.

91. The total outturn of the party is as follows:—

	Square miles.
Triangulation	44,375
Topographical survey, 6-inch scale	19
" " ½ " "	4,605
" " ¼ " "	3,700
Geographical " ¼ " "	56,420

92. During the recess all computations appertaining to the triangulation of the field season have been completed in duplicate, and the fair mapping of seven ½-inch standard sheets, four ¼-inch standard sheets, and four 6-inch sheets has been done.

93. During the year Sub-Assistant Superintendent Imam Sharif has returned from special duty with the Anglo-German boundary demarcation party in East Africa. He has been warmly commended for his able assistance as a topographer by the British Commissioner, and he has received a decoration from the Sultan of Zanzibar, which appears to have been thoroughly well earned. His health has suffered considerably from hard work and exposure.

94. The programme for the ensuing season, which is subject to modification, is as follows:—

Captain Mackenzie will continue the Zhob triangulation until a sufficiency of points for ½-inch topography have been secured in that valley.

Arrangements for a military survey for manœuvring purposes around Rawal Pindi on the scale of two inches per mile having been made in accordance with the requisition of the Military authorities, Mr. Claudius, with five or six surveyors and about ten soldier-surveyors, will commence on that work early in the season. Mr. Claudius should himself commence triangulation about the 15th October 1893, and the plane-tablers will probably be able to take up topography about a month later.

Mr. Wainright, with four of the best topographers, will complete the unmapped portions of the Bela and Wad districts on the ½-inch scale if political conditions permit.

Mr. Tate, with a small detachment of two native surveyors, will be in independent charge of the Aden cantonment survey, which will be finished this winter.

Khan Bahadur Yusáf Sharif and two native surveyors, will continue the Perso-Baluch coast survey on the lines already laid down.

Rai Bahadur Hira Singh and one native surveyor who has learnt traversing, will remain on settlement survey duty in Quetta.*

* Colonel Holdich reports that all his assistants, both European and native, gave entire satisfaction in the discharge of their duties.

HIMALAYAS, PUNJAB.

No. 18 Party.

95. This party remained under charge of Major St. G. C. Gore, R.E., throughout the year.

Personnel.

Major St. G. C. Gore, R.E., Deputy Superintendent, 1st grade, in charge.
Lieutenant C. H. D. Ryder, R.E., Assistant Superintendent, 2nd grade.
Mr. C. D. Potter, Extra Assistant Superintendent, 5th grade.
„ W. Robert „ 6th „
„ W. A. Fielding „ 6th „
„ P. E. Prunty, Sub-Assistant Superintendent, 1st grade.
„ R. W. Senior, „ 1st „

Surveyors and Sub-Surveyors.

Shah Nasiruddin, Atma Singh, Wahid Ali Khan, Ram Seran, Asmatullah Khan, Amir Singh, and 27 others.

96. The work executed during the field season was in continuation of that of previous years, and consisted of—

(i) a survey, on the scale of 4 inches = 1 mile, of the cultivated portions of the Kángra district with its sub-division of Kulu, the more mountainous portions and grazing-grounds being mapped on the smaller scale of 1 inch = 1 mile;

(ii) a survey on the scale of 4 inches = 1 mile of the Government forests in Kángra and Kulu;

(iii) surveys on the scale of 2 inches = 1 mile of the Simla Hill States with Mandi and Suket, particular attention being paid to the State boundaries;

(iv) a special survey on the scale of 4 inches = 1 mile of the reserved forests situated in the various Native States which constitute the Simla Hill States.

97. Two detachments under Messrs. Robert and Prunty, respectively, proceeded to Kulu early in September 1892, before the cessation of the rains, in order to utilise as much as possible the fine weather of the autumn in surveying the higher ground, the remainder of the party taking the field during October.

In December, when the winter snows rendered further work in Kulu impossible, the detachments were withdrawn and utilised, partly in surveying the lower ground in Mandi, where operations could be continued throughout the winter, and partly in strengthening the detachment which was working in Kángra under Mr. Fielding.

98. The special surveys of the forests in the Simla States were continued, a small detachment under Mr. Potter being employed in carrying on the mapping of the Patiala State forests.

The demarcation of most of these forests is very intricate, the average area of each forest block surveyed this season being only 0·17 square mile, and they are so mixed up with *zamindári* land that it becomes necessary, in order to make the maps of full value, to survey a large area of *zamindári* land in addition to the actual forest areas. Thus, though in the season under report only 27·7 square miles of forest were returned as completed, yet a total area of 66·3 square miles had to be surveyed in order to render the maps thoroughly useful.

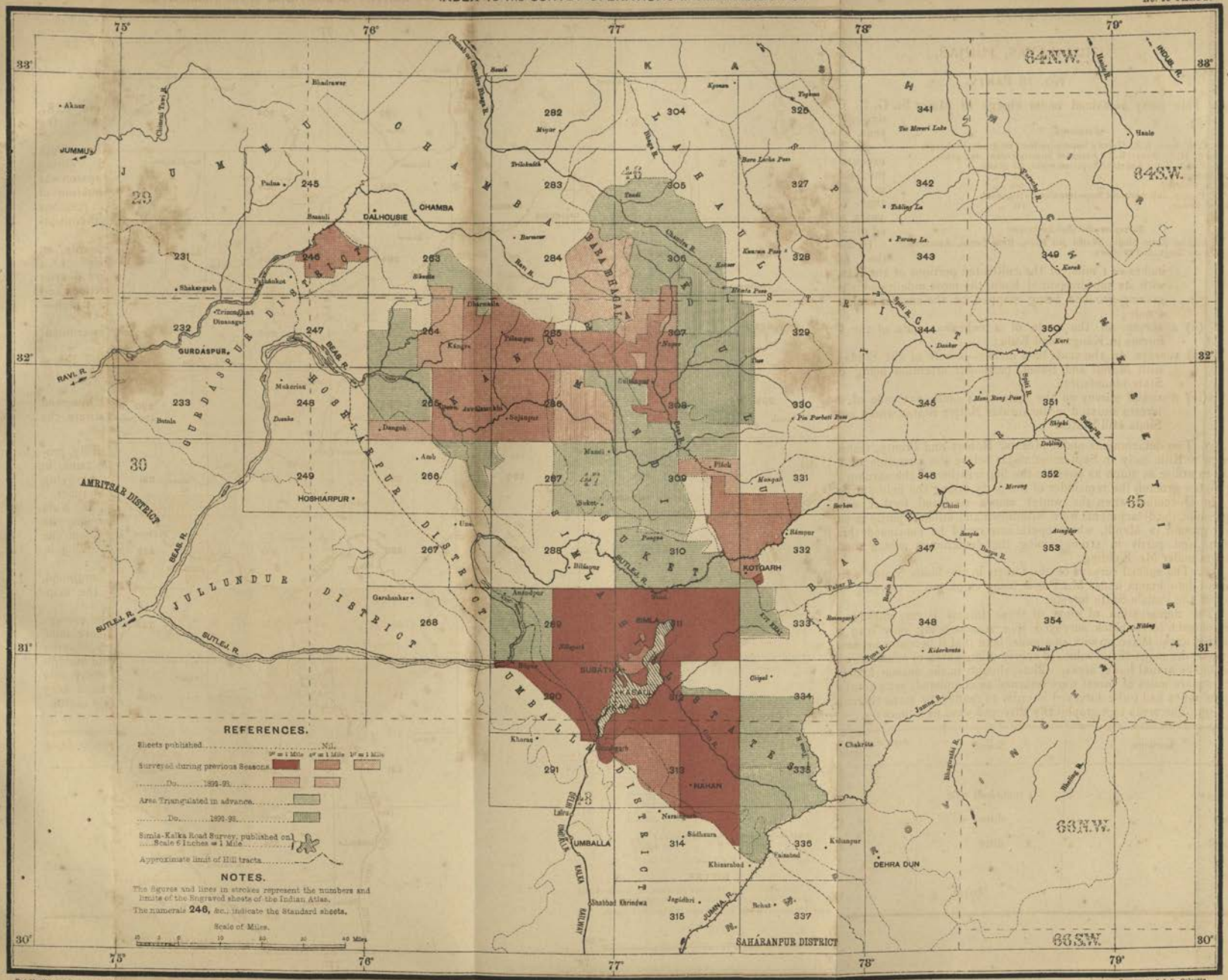
99. The areas topographically surveyed were as follows:—

Localities.	Scale.	Area in square miles, excluding forests.
Kángra	4 inches = 1 mile	200
Kulu	ditto	136
Mandi	2 ditto	212
	TOTAL	548

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS.

No. 18 PARTY.



Reg. No. 670, S. I. D.—Jan. 94—350.

Photo. S. I. O., Calcutta.

The forest blocks and areas surveyed were as follows, exclusive of 38·6 square miles of intermixed *zamindári* land above alluded to:—

Localities.	Scale.	Forest blocks.	Area in square miles.
Kulu	4 inches=	65	40·6
Kángra (Forest Department)	Ditto	5	0·9
Ditto (Deputy Commissioner)	Ditto	59	23·8
Hoshiárpur	Ditto	4	7·9
Simla Hill States (Patiala)	Ditto	134	27·7
	TOTALS	267	100·9

100. A considerable area of triangulation was completed during the year in Kulu by Mr. Senior. He reports that some of the ground in which demarcated forests lie is most difficult of access, and that it will be by no means easy for the detail surveyor to map it. The total area triangulated in advance for topography during the year was 1,254 square miles, of which 607 square miles were prepared for 4-inch, 559 for 2-inch, and 128 for 1-inch survey.

Mr. Senior has been awarded the Murchison grant for 1893 by the Council of the Royal Geographical Society for his surveys in the higher ranges of Kulu and Lahaul, where he has successfully carried out a laborious duty for several years in succession in the face of great hardships and difficulties.

101. The large scale survey of Kalka town, which was begun some years ago and suspended for want of funds, was, by request of the Deputy Commissioner, again taken in hand. The scale determined on was 48 inches=1 mile, but during the course of the survey, the Deputy Commissioner, at the instance of the Punjab Government, asked if the scale employed would be sufficiently large to record all existing projections into the main street and to prevent further encroachments. As this clearly was not the case, further measurements were taken, and at present sheets are being prepared showing the frontage of the principal streets on the large scale of 30 feet to 1 inch. These, it is hoped, will answer the purpose of enabling any encroachments to be ascertained by a periodical inspection.

102. Three soldier-surveyors were under instruction during the field season; of these two men of the Assam Military Police completed a three years' course of instruction in June and rejoined their battalion. The experiment of sending men without any previous training to undergo a course of survey and reconnaissance has not proved a success, and it has been determined not to repeat it. One soldier-surveyor has joined the party during the year for the usual course of instruction.

103. The programme for the ensuing field season comprises the continuation of the operations in Kulu Kángra and Mandi, the commencement of the special forest survey in Sirmur State, and the completion of the Kalka town survey.

104. The Deputy Surveyor General inspected the office of the party at Simla in June 1893, and reports that the administration of the party is all that could be desired under the efficient management of Major Gore.*

MERGUI DISTRICT, LOWER BURMA.

DETACHMENT.

105. The topographical work required to be done in Mergui consisted of (1) the 1-inch survey of the coal-fields and of the country between them and the town of Mergui, with the course of the Tenasserim river connecting them, and (2) the completion of the sheets to the south of the

Personnel.

Mr. J. A. Higgs, Sub-Assistant Superintendent, 1st grade, in charge.
5 sub-surveyors.

* Major Gore reports most favourably of Lieutenant Ryder, who has proved himself a very valuable officer, and also of Messrs. Potter, Robert, Fielding, Prunty, and Senior.
The services of Surveyor Shah Nasiruddin and Sub-surveyors Asmatullah Khan and Dan Singh are also commended.

district in Maliwun. As there was no means of communication between these two portions of country, it was impracticable for one officer to superintend the two; the survey of the northern portion was, therefore, handed over to No. 7 Party, a detachment of which was also employed in Mergui on cadastral survey. The supervision of this was entrusted to Mr. Gastaud, and to assist him three sub-surveyors from the Mergui detachment were transferred; two other sub-surveyors from Mr. Higgs' detachment also started work in this neighbourhood, *viz.*, in sheet No. 564, under Mr. Gastaud's orders, until Mr. Higgs could complete the work in Maliwun. The report on the work done by Mr. Gastaud's detachment will be found under the head of No. 7 Party. The southern portion, situated in sheets Nos. 570 and 571, was entrusted to Mr. Higgs with the remainder of the detachment, *viz.*, five sub-surveyors. In addition to the detail survey of these sheets in Maliwun, the triangulation in the south had to be completed by Mr. Higgs: orders were also given that, if time permitted, after the work in Maliwun was finished, this detachment should be moved northwards to assist in the survey of sheet No. 564.

106. The detachment left its recess quarters, Bangalore, on the 6th November and arrived at Mergui on the 16th idem; work was commenced in sheet No. 564 near Mergui on the 24th idem. Owing to the non-arrival of the survey launch from Rângoon, where it had been sent for repairs, the Southern detachment had to go to Bokpyin in the local steamer and then proceed in boats; there was then a little delay, owing to the necessity of clearing one of the trigonometrical stations, before work could be started, and hence it was not fairly commenced until the middle of December. The same difficulties with regard to the supply of provisions and keeping up of communication were met with again this year. As before, arrangements were made with Messrs. Lin Tha Dun & Co. to furnish supplies, and enough was taken down in boats to Bokpyin for the use of the detachment on its way to the work near Maliwun; another depôt was formed at the Mathei creek from which the sub-surveyors drew their supplies while at work. As the season advanced it was found necessary to open out two other depôts—one at the Pakchan river, and the other in the middle of the jungle: this last depôt was supplied from that at the Mathei creek, the only road between the two being the traverse line cut by the sub-surveyors in the course of their work. Country boats, canoes, and coolies were the usual means of transport between the more advanced depôts, the steam launch being utilised for bringing the supplies from Mergui to those on the sea coast or on the banks of rivers. It was mainly used however by Mr. Higgs when conducting the triangulation, as the Great Trigonometrical stations on which the whole depended, as well as others fixed by Mr. Higgs, are situated on the islands.

107. The field work was brought to a close by the end of May, when the establishment returned to recess quarters after accomplishing an outturn for the season of—

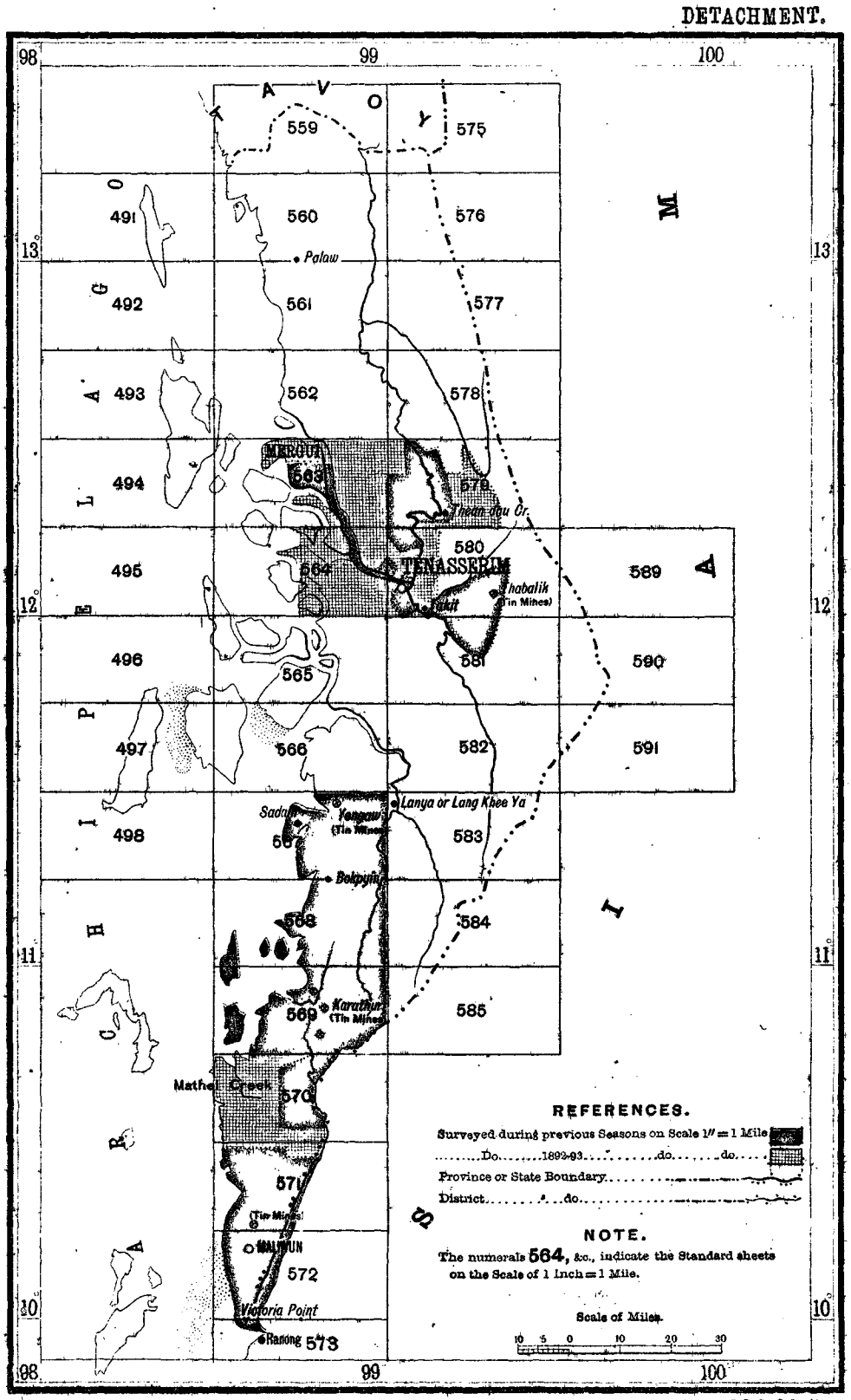
	Square miles.
Topography, 1-inch scale	679
Triangulation	1,500

108. The triangulation was started from the base Kauye and Lampi, two stations of the Great Trigonometrical Survey, and extended southwards. The length of time it took to clear the hills, and the non-arrival of the launch from Rangoon, delayed the commencement of the observations until the beginning of January; it was completed by the middle of March. Four islands were visited by Mr. Higgs whilst triangulating, *viz.*, Kauye, Lampi, James and Russell islands; the two last were visited with difficulty, even in the steam launch, being about 20 miles from the main land. Some anxiety was felt for the *khalásis* who were left on Russell island to clear the hill lest they should suffer for want of water; wells were dug and a supply thus provided for them, but the *khalásis* are generally so thoughtless and improvident that it was feared they would waste the small supply thus obtained, and perhaps be in difficulties before the steam launch could return to them; however fortune favoured them, and they did not meet with any great hardship. None of these islands are inhabited, though the Malay fishermen from Mergui and other places visit them at certain times of the year; an aboriginal tribe known as Selang are also found on them, and Mr. Higgs met with them on both James and Russell islands; they

BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN DISTRICT MERGUI.

DETACHMENT.



Reg. No. 661, S. I. D.—Jan. 94.—550

Photo., S. I. O., Calcutta.

No. 220-S. 94

are in general appearance like the Andamanese, but appear to be somewhat more civilised, as both men and women wear something in the shape of clothes. Their principal occupation seems to be diving for mother-of-pearl shells, which they barter for cloth, rice, etc., with the Chinese traders who cruise about in large boats. Bad weather interfered with rapid progress, the rain and mist obscuring the heliotrope signals for days together on some occasions.

109. The country topographically surveyed in the Maliwun township, amounting to 369 square miles, consisted mainly of a central range of hills of about 2,500 feet in height, running north and south and breaking up into a mass of lower ranges on either side; the drainage to the east falls into the Pakchan river, that on the west into large tidal creeks, the largest of which is the Mathei creek, which is upwards of two miles in width at its mouth. Both hills and valleys were alike covered with dense forests of huge trees, below which grew tangled masses of bamboo and cane; not a step could be taken without clearing. In the early morning, until dried by the heat of the sun, the whole vegetation was dripping with moisture, as though it had just ceased to rain heavily; the thick vegetable matter under foot harboured all kinds of objectionable insects, the most troublesome among which were the small leeches, which inserted themselves through the smallest interstices of the clothes, and were found not only on the lower parts of the body but even down the neck; their bites, though painless at first, often turned to ulcerous sores, very difficult to heal in some cases. Sandflies and mosquitos, though a minor evil, added to the discomfort of those whose misfortune it was to work in these jungles. Ordinary tents were not suited to the country, and the men lived under tarpaulins; raised platforms of bamboo were built and the tarpaulins were stretched over posts to form a roof; the walls were formed of branches of trees and leaves matted together. As rain falls more or less during every month of the year in these parts, the discomforts experienced were very great.

110. The country surveyed in sheet No. 564, which comprised an area of 310 square miles, was more open, and had the great advantage of being near the Great Tenasserim river which formed a line of communication with Mergui; there were moreover small villages scattered about, and the sub-surveyors could, as a rule, live in the Karens' huts. Though less difficult to survey than the country in Maliwun, yet here too the hills and valleys, except in the immediate vicinity of villages, were clothed with dense jungle, and the same discomforts from insects, etc., were met with as described above. The country near the sea was much intersected by tidal creeks fringed with mangrove swamps.

111. The health of the party was perhaps as good as could have been expected in such a malarious country; one of the sub-surveyors in Maliwun was in the field hospital at Bokpyin for about a month whilst being treated for dysentery, and about 5 per cent. of the *khalásis* suffered from the same complaint and from ulcers, from which one man died. In the Tenasserim detachment the men enjoyed good health until the end of the season, while they were surveying the swamps near the sea coast: they then suffered a great deal from ulcers. Mr. Higgs himself was the greatest sufferer of all: his system seems to have become thoroughly saturated with malaria, which produced not only fever but rheumatism of a very severe form, which terminated in the temporary loss of power in his left leg and arm. This officer deserves the utmost credit for his energy and pluck in continuing his work under great difficulties and when he was ill and in constant pain. Most men would have taken sick leave, which it would have been impossible to refuse, and the whole work of the detachment would have collapsed. But Mr. Higgs refused to give in and continued his triangulation, having at times to be carried up the hills.

112. The Deputy Surveyor-General visited Mergui in January 1893 and there he met Mr. Higgs, who had come to despatch the monthly papers to Calcutta and to consult the doctor. His state of health was such that the Deputy Surveyor-General insisted on his taking a rest for a week or ten days and placing himself in the hands of the Civil Surgeon. During this time the Deputy Surveyor-General utilised the steam launch in going up the Tenasserim river to meet the Deputy Superintendent of the Geological Survey, Mr. P. N. Bose, who was at work among the coal-fields to the east of Mergui. On his return he found Mr. Higgs better, though far from well, but able to start

southwards again in the launch to continue his work. The Deputy Surveyor-General states that he was satisfied that the work was making as good progress under Mr. Higgs as could possibly be expected, and that he was much pleased by the zeal and energy displayed by that officer.

113. The party returned to Bangalore after the field work was closed, and commenced recess work on the 19th June. To assist in bringing up the work, more especially the maps of the coal-fields, Mr. Gastaud, of No. 7 Party, was temporarily attached to the detachment. It is gratifying to be able to report that the complete change of climate enabled Mr. Higgs to almost recover his health, and it is to be hoped therefore that the exposure to which he has been subjected will not have a permanently bad effect.

114. It having been finally decided that no more topographical survey is required at present in the Mergui district, the detachment will be abolished.*

INDUS RIVER, SIND.

DETACHMENT.

115. In consequence of the great changes that have taken place in the course of the River Indus in Sind since the last survey of that province, which was made in the years 1856 to 1870, the Bombay Government, in 1891, asked for a detachment to make a re-survey of that river, the provincial Survey Department being unable to undertake it. At that time it was not possible to comply with their request, and the question was postponed. It was again brought forward in 1892, and the orders of Government sanctioning the re-survey were conveyed in No. $\frac{1498}{1609}$, dated 18th July 1892, from the Revenue and Agricultural Department, to the Government of Bombay. Instructions to organise a suitable detachment were then given to Mr. J. S. Pemberton, who, in 1890-91, had made for the Punjab Government a similar survey of the Indus between Bahawalpur and the district of Dera Ghazi Khan. His services however being urgently required in Bihar, the superintendence was made over to Mr. H. E. T. Keelan, who assumed charge on the 20th October 1892.

Personnel.

Mr. H. E. T. Keelan, Extra Assistant Superintendent, 1st grade, in charge.
9 sub-surveyors.

116. The requirements of the Bombay Government were as follows :—

A survey on the scale of 1 inch = 1 mile of the River Indus from the boundary between Sind and the Punjab to the sea, which was to include not only the recognised deep channel but all minor channels up to what is known as the "pucka bank;" it was also to include all river embankments, and where these did not exist it was to extend to a distance of half a mile from the river bank. The total length of this area for survey is about 390 miles; the width of it varies greatly, so it is difficult to give its exact area; but it has been estimated to be about 3,500 square miles, and that it would occupy the detachment three years; it is doubtful however whether the detachment, if kept at its present strength, will be able to accomplish this.

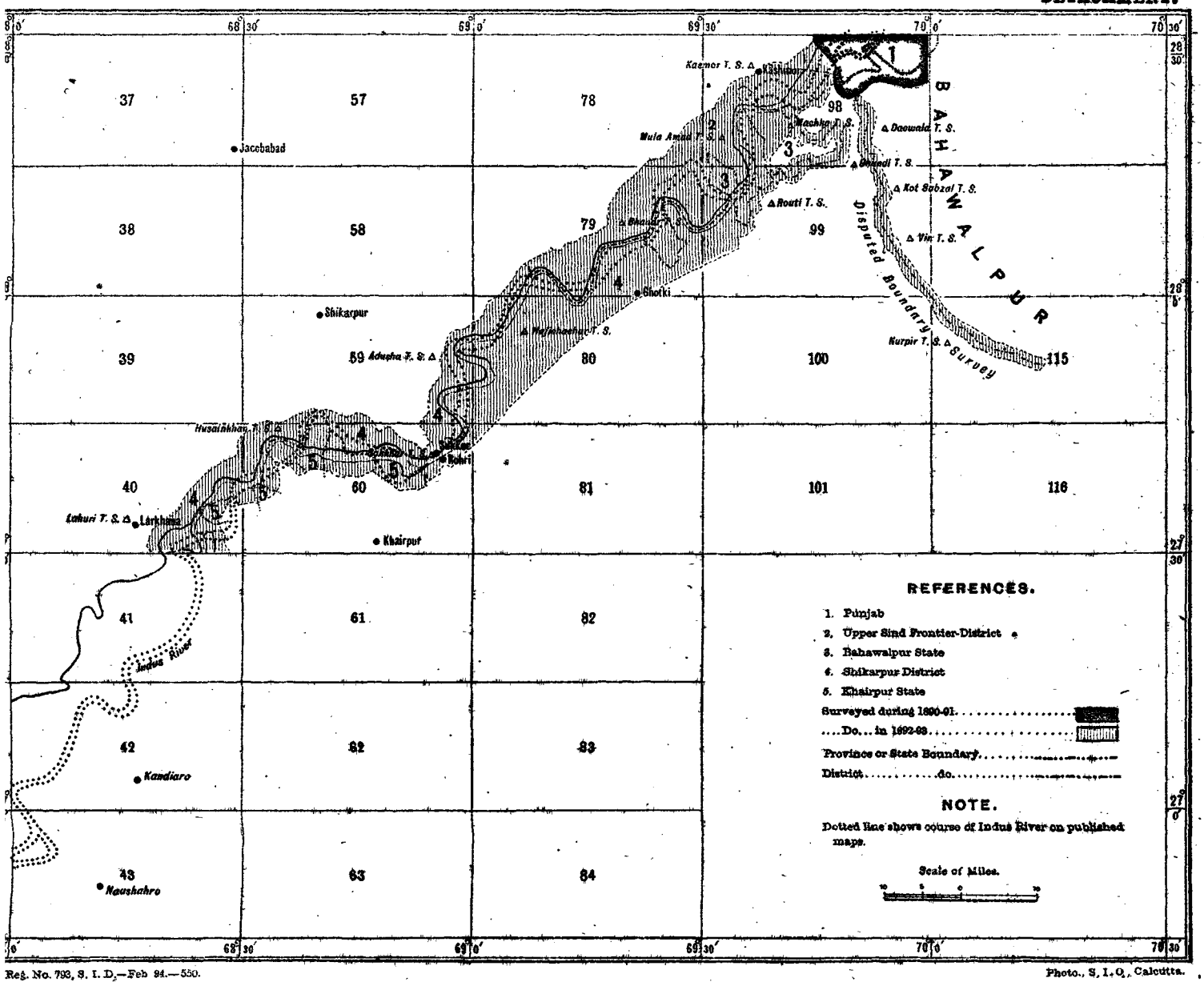
117. The men were all assembled at Sukkur, the place selected for the head-quarters camp, on the 8th November 1892, and by the 17th all was ready for commencing the field work. Traversing was started from Kashmor in the Jacobabad district, where the work of the previous detachment ceased, and was carried nearly to Larkhana in the Shikarpur district, a distance of about 111 miles. Connections were made with 10 stations of the Great Indus trigonometrical series; the comparison of distances thus derived was satisfactory, giving an average error of $3\frac{1}{2}$ feet per mile. Traverse work was closed about the 1st May 1893. During the early part of the season the progress was slow, owing to the heavy line-clearing that had to be carried through extensive stretches of jungles and forest reserves which were found on both banks of the river. There was considerable opposition on the part of the villagers, who at first refused to render the necessary assistance in the cutting of these lines, which had to be carried on

* Mr. Higgs calls attention to the good work done in the field by Sub-Surveyors Shedi Lall, Sakhawat Hosein and Ori Pandi, particularly the last named, who alone surveyed 224 square miles of difficult country. The writer, Babu Sanath Kumar Chatterjee, also discharged his duties satisfactorily.

SIND SURVEY.

INDEX TO THE INDUS RIVERAIN SURVEY.

DETACHMENT.



Reg. No. 793, S. I. D.—Feb 94.—550.

Photo., S. I. O., Calcutta.

No. 240-S. 94.

simultaneously with the traverse work. In addition to this, three out of the nine sub-surveyors were laid up with fever for two or three weeks, and it was not until after December that all were fairly at work and steady progress was made.

118. All the traverse stations were temporarily marked by stout wooden pegs, 3 feet long, driven into the ground to within a few inches of the top; in a few cases these were uprooted by the villagers, but as a rule they were found intact by the detail surveyor. The permanent marking of such stations as were required for future reference was undertaken by the Public Works Department in communication with Mr. Keelan.

119. Owing to the fact that almost the whole of the country to be surveyed is more or less subject to river action, it was useless to carry the traverse work in advance for the detail survey of next year, as the temporary marks would have been destroyed during the rainy months, and the whole of the advance traverse work would thus have been rendered useless. The want of traverse survey in advance will naturally check the progress of the detail survey, as it will each year delay its commencement; but there does not appear to be any remedy, unless every theodolite station were so marked as to be able to withstand the action of the floods: the expense of doing this however would render it prohibitive, even if it were possible. The season's work was divided into six main circuits and 16 sub-circuits, which covered an area of 1106 square miles; the number of linear miles, all of which were measured with two chains, amounted to 1,470.

120. Duplicate plots of the traverse stations were prepared as soon as possible for the use of the Irrigation Branch of the Public Works Department, and were submitted to the Commissioner of Sind.

121. The detail survey was commenced in the middle of January and closed on the 18th May, when the detachment moved into recess quarters at Kurrachee. The survey was conducted with plane-tables and was based on the traverse stations; its accuracy was tested by check lines run through different sections, 11 out of 15 being thus checked by lines aggregating 75¾ linear miles in length; but very few errors were detected, and those were not of an important character. The total results of the season's work along the Indus river are given in the following statement:—

District or State.	Traverse survey.			Topographical survey, 1 inch = 1 mile.	Remarks.
	Number of villages.	Number of traverse stations.	Linear miles.	Area in square miles.	
Dera Ghazi Khan (Punjab)	1	35	50	13·7	The total areas of the villages were not in all cases surveyed, as in some portions fell beyond the limits of the survey.
Upper Sind Frontier	30	1,193	372	327·6	
Shikarpur	158	3,183	943	651·1	
Bahawalpur State	4	140	34	54·1	
Khairpur „	10	157	71	67·8	
Totals	203	4,708	1,470	1114·3	

122. In addition to the re-survey of the Indus, the survey of the boundary between Sind and the State of Bahawalpur was undertaken by this detachment at the request of the Commissioner of Sind, the expenses to be shared between the parties concerned, commencing from the tri-junction of the boundaries of Sind, Bahawalpur, and Jeysulmere. The first portion ran through the *thal* or desert, and this was to be demarcated according to the Sind Revenue Survey of 1856-57 and masonry pillars erected at the principal points; the second portion ran along the Guddu Dhand, a minor channel of the Indus, and in this were numerous disputes. No attempt on the part of the surveyor was to be made to settle these disputes, but he was to make a careful map, showing the disputed areas and the boundaries claimed by each side. In order to show the details clearly, it was found necessary to make this boundary survey on the scale of 2 inches = 1 mile. Traversing was commenced at the same time as that on the Indus, and the detail survey began about the 1st December 1892: the whole was

completed in April 1893. The total length of the boundary traversed was about 140 miles, and the area of detail survey amounted to 127 square miles. Two chains were used throughout, and the work was connected with seven trigonometrical stations, the error per mile proving to be 1·83 feet only. Representatives from the Bahawalpur State and from the Shikarpur district were present during the survey. In the first section, temporary but conspicuous marks were erected at 33 of the theodolite stations where it was considered advisable that permanent boundary pillars should be built: in May these were replaced by masonry pillars 8 feet high and 4 feet square, which were built by the Shikarpur authorities. In the second section of the boundary, Mr. Keelan requested the district officials to have all the theodolite stations temporarily marked so as to preserve them until the disputes could be settled and the boundary finally demarcated.

123. Recess quarters were with considerable difficulty found for the party at Kurrachee: this difficulty is mainly due to the fact that owners object to let their houses for short periods. During the recess season the fair mapping of the nine sheets of the Indus riverain survey and of the seven sheets of the survey of the Sind-Bahawalpur boundary was completed; tracings of the latter were also prepared for the Bahawalpur authorities; duplicate copies of the traverse data, of which plots had already been furnished, were made for the Irrigation Branch of the Public Works Department.

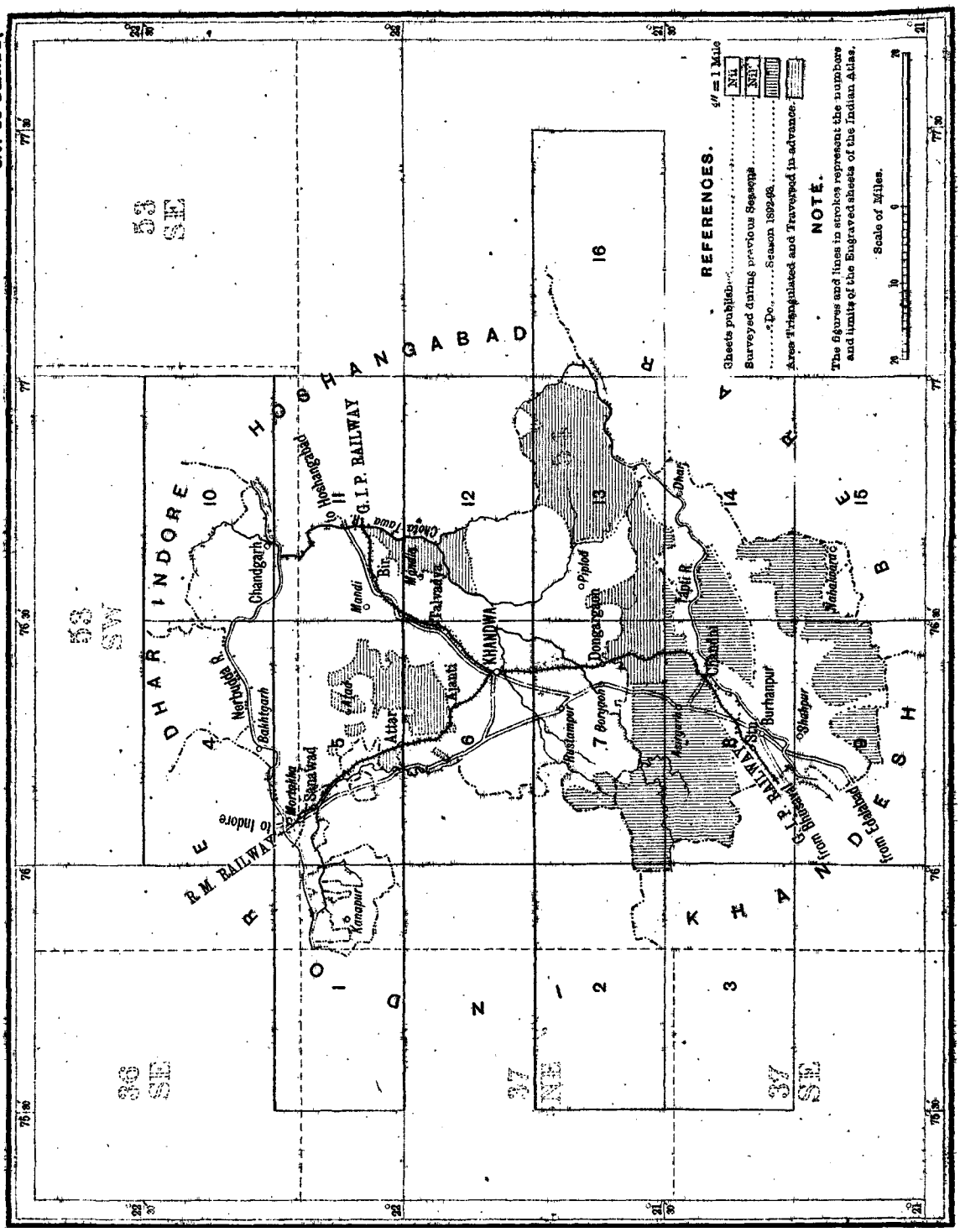
124. The total expenditure amounted to R24,610, of which R794 was expended on the survey of the Sind-Bahawalpur boundary. The cost-rate per square mile of the Indus riverain survey is R21-6-5.

125. During the coming field season the traverse and detail survey of the Indus will be carried on as before; but in addition to this it will be necessary, owing to the distance of the trigonometrical series from the river, to undertake some triangulation to furnish checks to the chained traverse lines; an additional officer will, if available, be temporarily attached to the party for this purpose.*

* Mr. Keelan reports that the sub-surveyors and computers, with only one exception, worked with zeal, energy, and accuracy throughout the season.

CENTRAL PROVINCES SURVEY.

INDEX TO THE FOREST SURVEY IN DISTRICT NIMAR. No. 14 PARTY.



Ret No. 474, S. I. D.—Jan. 94.—550.

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FOREST SURVEYS.

CENTRAL PROVINCES.

No. 14 Party.

126. On completion of the survey of forests in district Hoshangabad and that portion of Betul of which forest traces were supplied by the Conservator, this party was transferred to Nimar district, where the survey of 1st class forests on the 4-inch scale had been allotted to it.

Personnel.

Colonel J. R. Wilmer, S.C., Superintendent, 2nd grade, in charge.
Mr. N. C. Gwynne, Extra Assistant Superintendent, 2nd grade.
„ J. Keating, Sub-Assistant „ 1st „
„ D. Campbell „ „ „ „
„ B. R. Hughes „ „ „ „
Munshi Rahmatullah „ „ 3rd „
Mr. J. O. Greiff „ „ „ „

Surveyors and Sub-Surveyors.

Mohammad Zakaria, Hydar Ali, Gurdutt Singh, Kadir Sharif, and 50 others.

127. The party assembled at Burhánpur, district Nimar, on 1st December 1892, and field operations were commenced in the third week of December and continued till the end of April 1893.

128. The field work of the season consisted, as usual, of triangulation and traversing in advance of topography, detail survey on the 4-inch scale, and classification of forest growth and soil of the ground surveyed in detail.

129. Triangulation was carried out in sheets Nos. 5, 6, 7, 11, 12, and 13, aggregating 873 square miles. Out of this area, 87 square miles was also surveyed in detail in the season under report, leaving 786 square miles in advance for next year. Of this however only about 410 square miles will require detail survey on the 4-inch scale. The excess is due chiefly to *malguzari* and other lands which intervene between the forest blocks being included in the total area reported.

130. Traversing with theodolite of 605·36 linear miles was done, mostly on the ground triangulated, but partly also in the detail survey work where needed. The object of this was to take up all the forest boundaries and fire lines and to supply additional fixed points for detail survey. Some delay and inconvenience were experienced in this work owing to the boundaries of forests not being properly demarcated. In many cases the boundary pillars were not put up in time for survey, the result being that some boundaries must be re-traversed in the ensuing season. Such, for instance, is the case with the boundary between Holkar's territory and Nimar. The fair maps in which this boundary falls have to stand over till the coming field season, pending the revision and correction of that boundary traverse.

131. Detail survey was executed in Jambupáni, Ichhádevi, Shámardeo, Mándwa, Ásir, Amba and Bhainsa, 1st class reserves of district Nimar. The area surveyed was 627·67 square miles. This was tested by the European assistants by *in situ* fixings and check lines of a total length of about 330 miles. The executive officer also visited almost all the plane tables and inspected their work while in progress.

132. The classification of forest growth and soil was continued in district Nimar according to the requirements and wishes of the Forest Department. All the area surveyed in detail was thus classified on separate skeleton traces by the surveyors in the field, and fair maps thereof were prepared in recess and supplied to the Forest Officers in original.

133. The country surveyed consisted mostly of low hills with light forest. Portions of Jambupáni, Ásir, Shámardeo, and Amba reserves are very hilly and covered with grass. In some parts the thorny *khair* bush abounded, tearing the men's clothes and making the work tedious. A considerable portion of these hills was covered with *salai* trees, a tree of little use for any purpose. The fortress of Ásirgarh falls in the Ásir reserve. A complete description of this is given in the Gazetteer of the Central Provinces and needs no further remarks. The Great Indian Peninsula Railway from Bombay to Jubbulpore crosses Mándwa reserve from south to north. The only high roads in the area surveyed are a few miles of the metalled road from Chandni railway station to Ásirgarh, and the well-known road from Burhánpur to Khandwa, which passes through Ásir reserve. The Tapti, the only river of importance met with, flows from east to west, touching Shámardeo reserve on the north.

The ground surveyed was very unhealthy and the water-supply scarce, especially after the end of March. Cooly labour was obtained with difficulty throughout the season. Provisions too were not obtainable in the forests, and had to be imported by five sets of *banias* engaged through the *tahsildar*.

134. The health of the establishment in the season was no better than last year. Unfortunately in January there were heavy rains, and in consequence pneumonia, feverish colds and coughs, broke out almost in every squad, and the men who suffered remained convalescent throughout the season. Towards the end, dysentery, fever, and sunstroke were also prevalent, and the party was deprived by death of 13 men, who succumbed to one malady or another during the season.

135. All the fair-mapping and computations pertaining to the season's operations have been finished, and there are no arrears in either work. The mapping comprises 32 standard-sized maps of sheets Nos. 7, 8, 9, 14 and 15, all of which have been drawn and submitted for reproduction, with the exception of four, in which a boundary traverse has to be corrected and completed in the ensuing field season.

The General Report of the Hoshangabad and Betul Survey is making steady progress. Letter press of Degree Sheet V N.E. and VII N.W. is finished, and triangulation charts of the same degree sheets have been drawn on the scale of 1 inch=1 mile in $\frac{1}{4}$ degrees for reduction to half scale. These contain not only the triangulation but also the general run of the traverses falling in the quarter degree sheets.

136. It is satisfactory to note that the cost of survey for each description of work is again lower this year than last year, being R21-8-4, R18-15-11, and R99-8-8 for traversing, triangulation and detail survey, respectively, against R22-8-3, R21-2-6, and R118-13-11 last year.

137. Three military students were attached to the party in the season under report. Two of them, after fully completing their course of survey training, went back to their respective regiments at the end of the field season, and the third was permanently appointed to this party as a sub-surveyor at his own request and on his commanding officer willingly giving up his services.

The various branches of survey work in which these men have been trained are briefly these:—

1. Plane-tabling on 4-inch scale, including determination of heights by clinometer and contouring;
2. Traversing with theodolite;
3. Traversing with prismatic compass;
4. Route surveying with prismatic compass and theodolite;
5. Use of theodolite and sextant for time and latitude observations;
6. Hill-shading (horizontal); and
7. Plotting.

138. The programme of work for the ensuing field season is as follows:—

(*a*) Triangulation of about 400 square miles in district Nimar in sheets Nos. 4, 5, 10 and 11, and of about 350 square miles in district Betul in sheets Nos. 20, 21, 27, 28, 38, and 39;
(*b*) Theodolite traversing of about 600 linear miles;
(*c*) Detail survey of about 550 square miles in district Nimar in sheets Nos. 4, 5, 6, 7, 11, 12 and 13; and
(*d*) The classification of forest and soil of the area to be surveyed in detail.

139. The office of the party was inspected by the Deputy Surveyor-General in charge Trigonometrical Branch on 16th October 1893, who remarked as follows:—

"I have much pleasure in expressing my satisfaction at the efficient state in which I have again found your party and at the orderly and methodical way in which the large amount of mapping and computation which passes through your hands is dealt with."*

* Colonel Wilmer reports very favourably of his assistants—Messrs. Gwynne, Keating, Campbell, and Hughes.

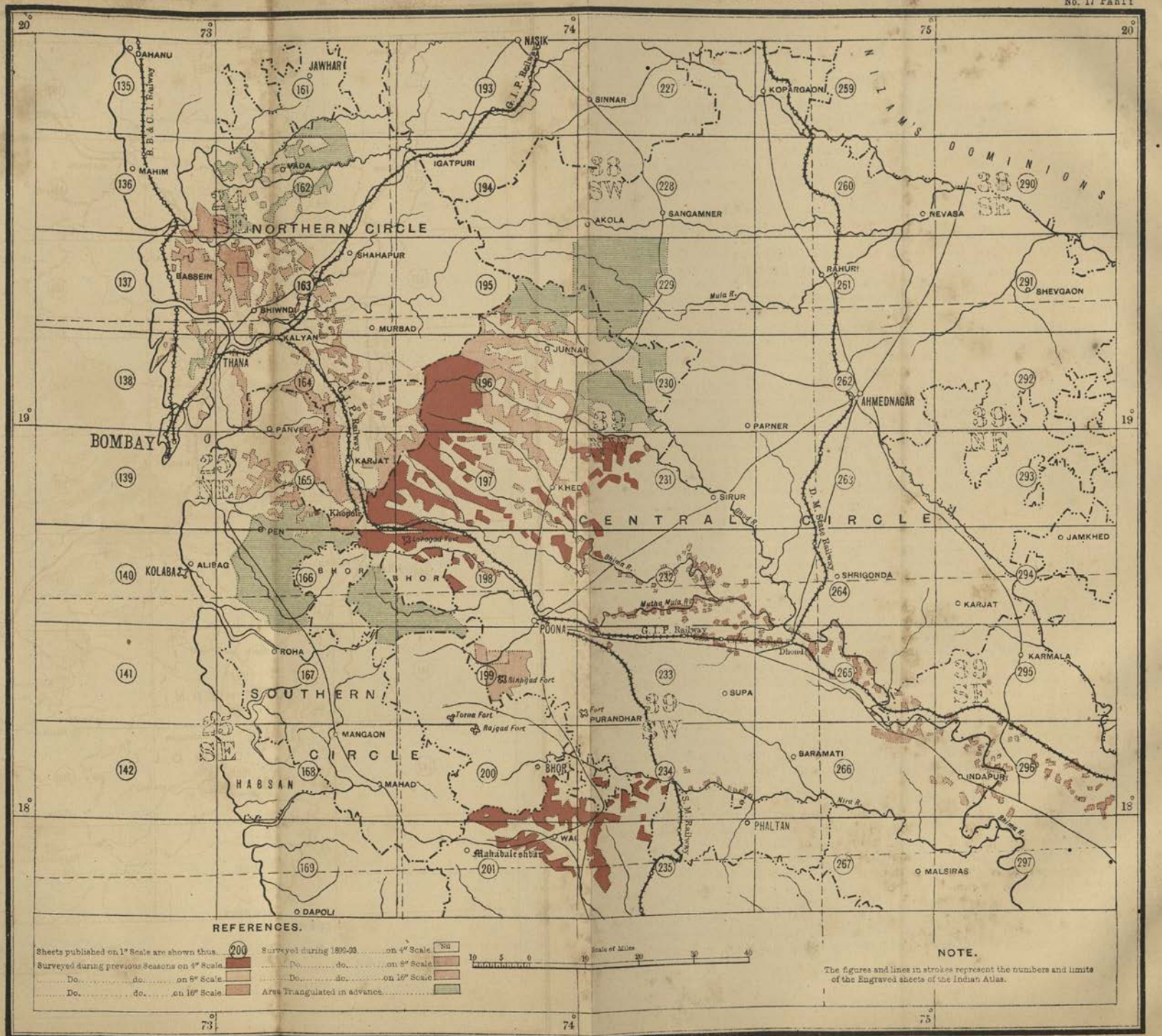
Mr. Greiff and Munshi Rahmatullah were under instruction, and both have made considerable progress.

The following members of the native establishment are favourably mentioned by Colonel Wilmer: Mohammad Zakaria, Hydar Ali, Gurdutt Singh, Kadir Sharif, Ram Singh, Mahadeo Daji, Sutto Charan Ghosal, Surjan Singh Abdul Haq(1), Sita Ram, Dharmu, Baij Nath, Mohindro Nath Bose, Syed Razi Hasan, and more especially the Head Clerk, Syed Zille Hasnain.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN PORTION OF THE NORTHERN CIRCLE.

No. 17 PARTY



REFERENCES.

Sheets published on 1" Scale are shown thus 200

Surveyed during previous Seasons on 4" Scale

Do. do. on 8" Scale

Do. do. on 16" Scale

Surveyed during 1899-93 on 4" Scale NS

Do. do. on 8" Scale

Do. do. on 16" Scale

Area Triangulated in advance

Scale of Miles 10 5 0 10 20 30 40

NOTE.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

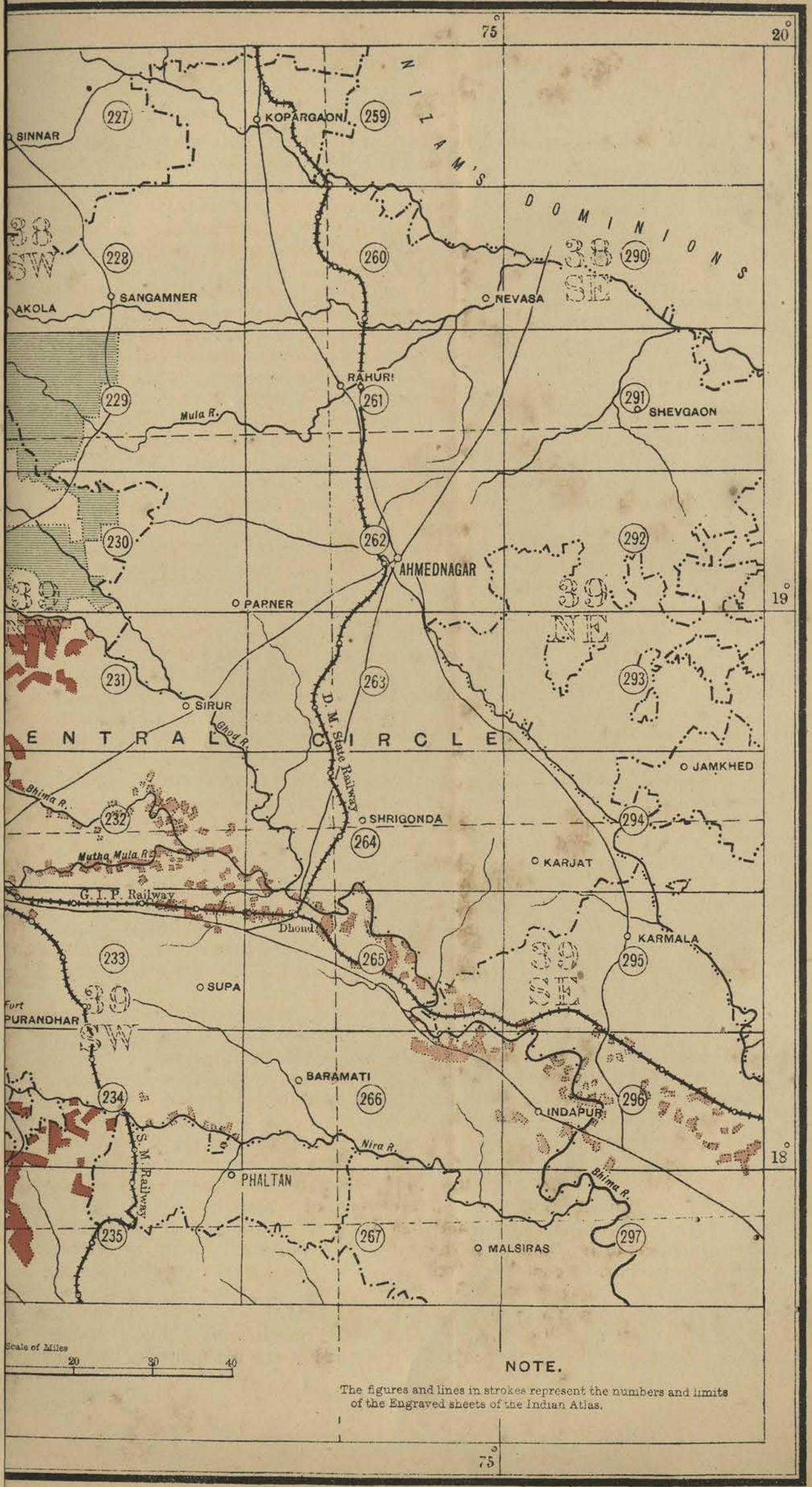
Photo., S. I. O., Calcutta.

No. 219-S. 94.

SURVEY.

PORTION OF THE NORTHERN CIRCLE.

No. 17 PARTY



NOTE.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Photo., S. I. O., Calcutta.

No. 219-S. 94.

BOMBAY PRESIDENCY.

No. 17 PARTY

140. The party remained in the charge of Colonel H. S. Hutchinson throughout the year. The field operations commenced on the 15th October 1892, and were brought to a close on the 31st May 1893. The work was restricted, as in former years, to forest tracts in the Bombay Presidency.

Personnel.

Colonel H. S. Hutchinson, S.C., Superintendent, 2nd grade, in charge.
Mr. A. M. Lawson, Extra Assistant Superintendent, 1st grade.
Mr. S. F. Norman, Sub-Assistant Superintendent, 1st grade
Mr. C. A Norman, Sub-Assistant Superintendent, 1st grade.

Surveyors and Sub-Surveyors.

Gopal Vishnu, G. R. Bhopatkar, Govind Gopal, R. V. Joshi, N. V. Bhopatkar, V. G. Bhat, and 23 others.

141. The establishment for topographical work was divided into two sections, and one European assistant was engaged during the greater part of the season on triangulation and traversing in advance for the following season's detail survey work.

The first section undertook, in the first instance, the survey of the *babul* reserves on the 16-inch scale in and about the Poona district (Central Circle). It then moved into Kanara in the Southern Circle, and worked there for 3½ months on 4-inch topographical survey, after which it was employed for one month on 8-inch topographical survey in Kolaba district (also in the Southern Circle).

The second section worked for four months on 8-inch topographical survey in the Poona district, Central Circle, and for three months on topographical survey on the same scale in the Thana district, Northern Circle.

142. The 16-inch survey of *babul* forest blocks in the Central Circle was commenced on the 15th October 1892 by eight sub-surveyors and their squads, in three different localities, in and about the Poona district. These detachments were superintended by Colonel Hutchinson, Mr. A. M. Lawson, and Mr. C. A. Norman. The work was continued up to the 25th of December, an area of 21·5 square miles being completed. This area is less than that done by an equal establishment last year, which is accounted for by much of the work done being mere fringes of *babul* growth on river banks, enclosing very little area, but which, by their scattered and extended character, as well as by the broken nature of the ground, involved much time and labour in surveying.

143. This section then moved into the Kanara district, Southern Circle, where it was employed for three-months-and-a-half, under Mr. A. M. Lawson, upon 4-inch detail survey, and completed an area of 220 square miles, finishing this work on the 15th April 1893. The section then moved up the coast to the Kolaba district and worked under Mr. C. A. Norman for six weeks in the Pen *taluka*, completing 16 square miles on the 8-inch scale by the end of May, when it returned to Poona. By these arrangements the establishment worked in the Kanara forests only for the three most healthy months, and consequently suffered less from fever than might otherwise have been the case.

144. The second section, consisting of eight sub-surveyors and their squads, left Poona for Junnar on the 1st November 1892 under Mr. S. F. Norman, and worked in that *taluka* for four months upon 8-inch topographical survey, completing 96·5 square miles by the end of February; they then marched *vid* the Nana *ghát* to the nearly adjoining *talukas* of Salsette and Bassein in the Thana district, and worked there, also upon the 8-inch scale, up to the end of May, when they returned to Poona, having completed an area of 60 square miles. A small area of 12 square miles was also surveyed during October 1892 by two squads of this section before leaving Poona for Junnar: this work was needed in order to complete up to margin the special forest map of Singarh hill.

145. Triangulation was undertaken in the Kanara district by Mr. C. A. Norman from the 1st January to the 15th April 1893, and during these three-and-a-half months he completed 600 square miles in a most trying and difficult country.

Triangulation was also undertaken by Mr. A. M. Lawson after the completion of the 4-inch detail survey in Kanara, in the Haveli *taluka*, Poona district, where 150 square miles were covered at the head of the Mootha river valley by

the end of May, when Mr. Lawson returned to recess quarters. Triangulation was also done throughout the season by Gopal Vishnu, first in the Junnar *taluka*, where he worked for four months and completed 230 square miles, and afterwards in the Wada *taluka*, where he worked for three months, completing 165 square miles, and then returned to Poona at the end of May.

146. The Superintendent visited in succession all the different works and examined a percentage of the survey in each locality. Every plane-table was tested by European agency, and the work was found on the whole to be good and accurate. The aggregate amount of rigid chain check survey amounted to 260 linear miles. Of the area triangulated, 400 square miles in the Southern Circle and 395 square miles in the Northern and Central Circles is work done in advance for next season. Of the traverse work done, 200 linear miles in the Southern Circle and 34 linear miles in the Northern Circle is advance work.

147. The aggregate outturn and average cost-rate of all the different works done during the field season stands as follows:—

Description.	Area.	Cost-rates.		
	Square miles.	₹	*a.*	*p.*
Triangulation	995	13	0	0
Traversing	310	21	12	1
Topography, 16-inch scale	21·5	189	12	3
Ditto, 8 do.	185	150	14	0
Ditto, 4 do.	220	80	9	6

A description by Colonel Hutchinson of the country surveyed will be found in the appendix.

148. During recess the computations and mapping of all the current season's work has been completed as follows:—

4-inch standard maps	10
2 " " "	2
8 " " "	45
16 " " "	39
Triangulation and traverse charts	7
TOTAL	103

149. The general health of the party was good; but some of the surveyors, after leaving Kanara, suffered from fever, and this reduced a good deal the anticipated area of 8-inch work in the Kolaba district. No very serious cases however occurred, and on the whole they have suffered less than in former seasons.

150. The programme for the ensuing field season is as follows:—

Northern Circle.—In the Thana district, continuation of 8-inch detail survey in the Wada and Salsette *talukas*.

Central Circle.—In the Poona district, Junnar *taluka*, continuation of 8-inch detail survey; and in the Poona and Sholapur districts, continuation of the 16-inch surveys of the *babul* forests on the Ghod, Godavari, and Bhima rivers and their tributaries. Also advance triangulation in the Haveli and Purandhar *talukas* of the Poona district.

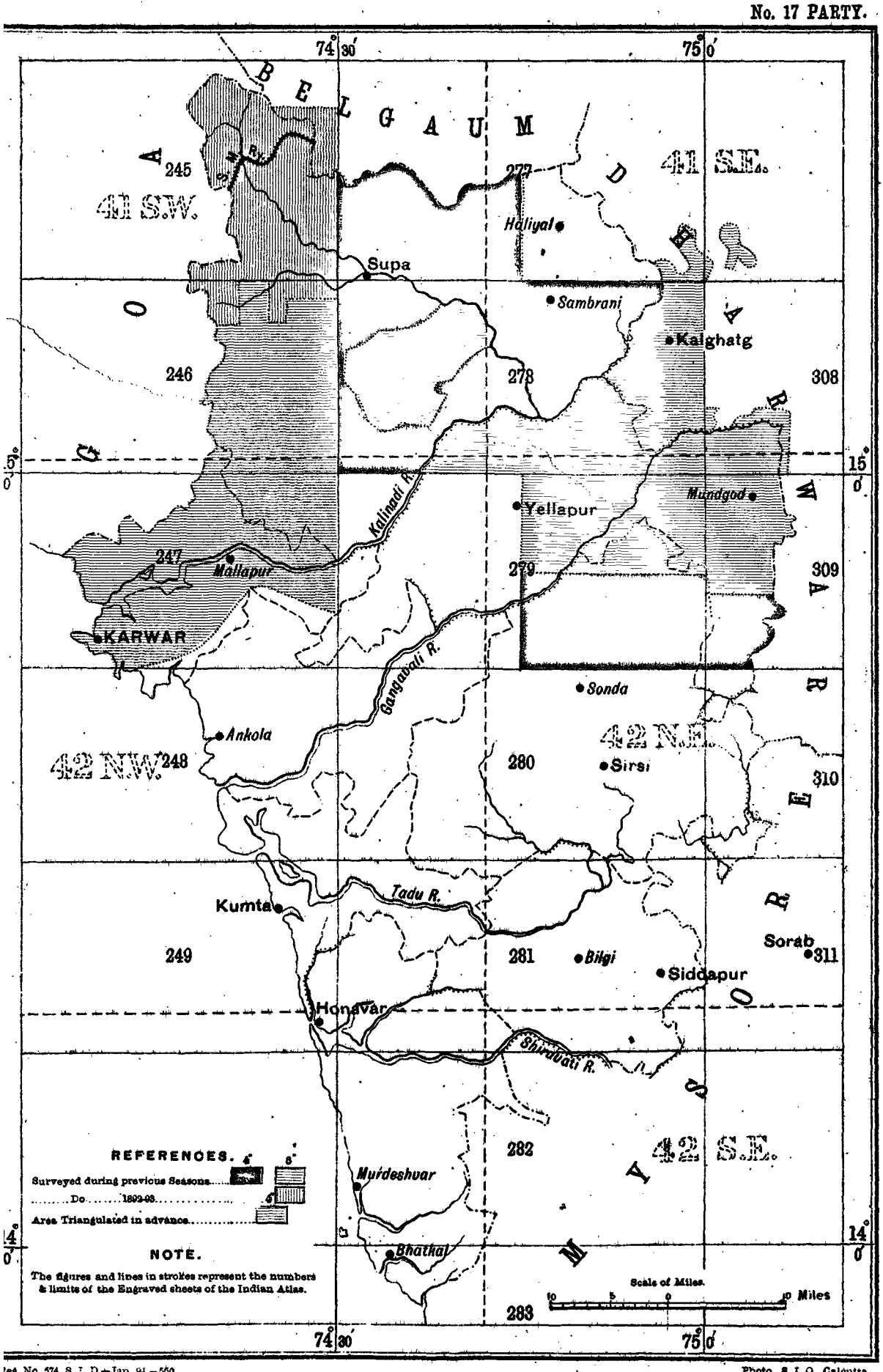
Southern Circle.—Kolaba district, Pen *taluka*, continuation of 8-inch detail survey. North Kanara district, continuation of 4-inch detail survey on the Goa frontier. Also advance traverse work in Sheet 247.

151. The Surveyor-General inspected the recess office of the party in September 1893, and found the progress that had been made in the current season's work to be very satisfactory. The field maps are well and carefully executed and, in the case of the 8-inch surveys, were utilized as the means of reproduction, which obviates the labour of re-drawing them during the recess and avoids the danger of the mapping falling into arrears. The mapping generally has been skilfully executed, showing well the marked character of the hill features and in a manner well suited for reproduction. The records are carefully kept. The triangulation and traverse charts, which were found in a somewhat backward

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SOUTHERN CIRCLE (N. KANARA).

No. 17 PARTY.



Reg No. 574, S. I. D.—Jan. 94.—550

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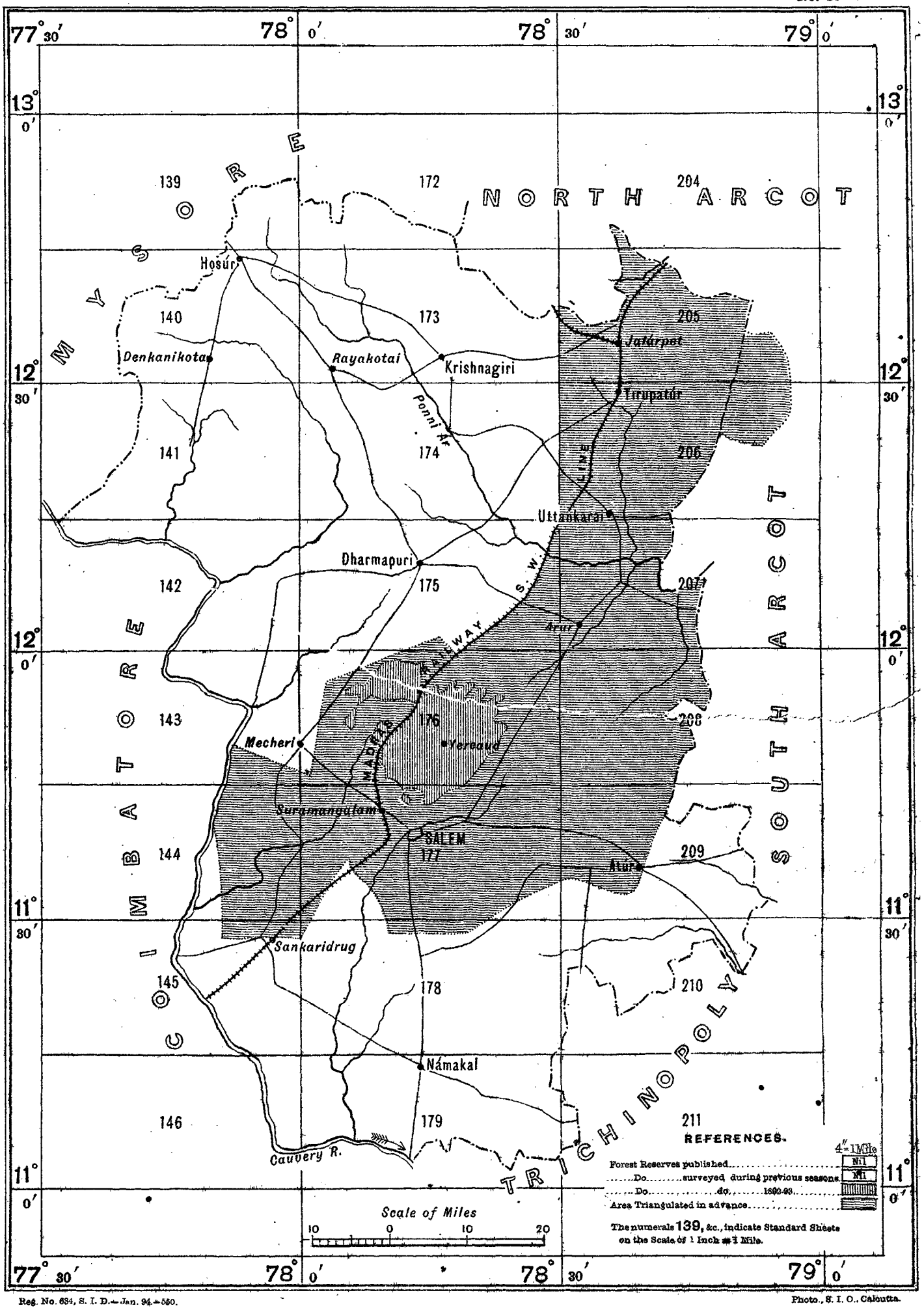
No. 214-S. 94.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SALEM DISTRICT.

No. 19 PARTY.



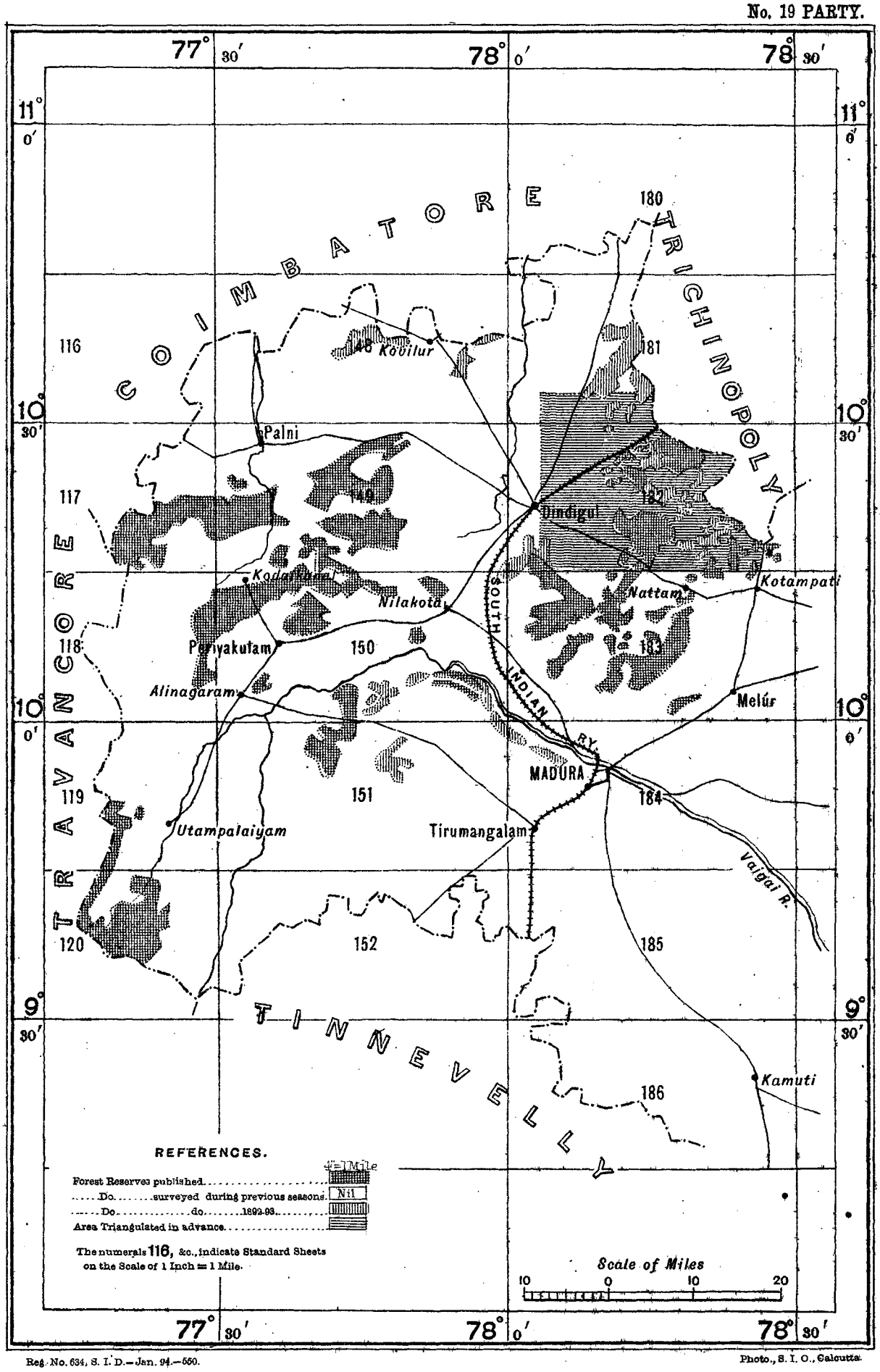
Reg. No. 634, S. I. D.—Jan. 94.—550.

Photo., S. I. O., Calcutta.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE MADURA DISTRICT.

No. 19 PARTY.



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MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE COIMBATORE DISTRICT.

No. 19 PARTY.

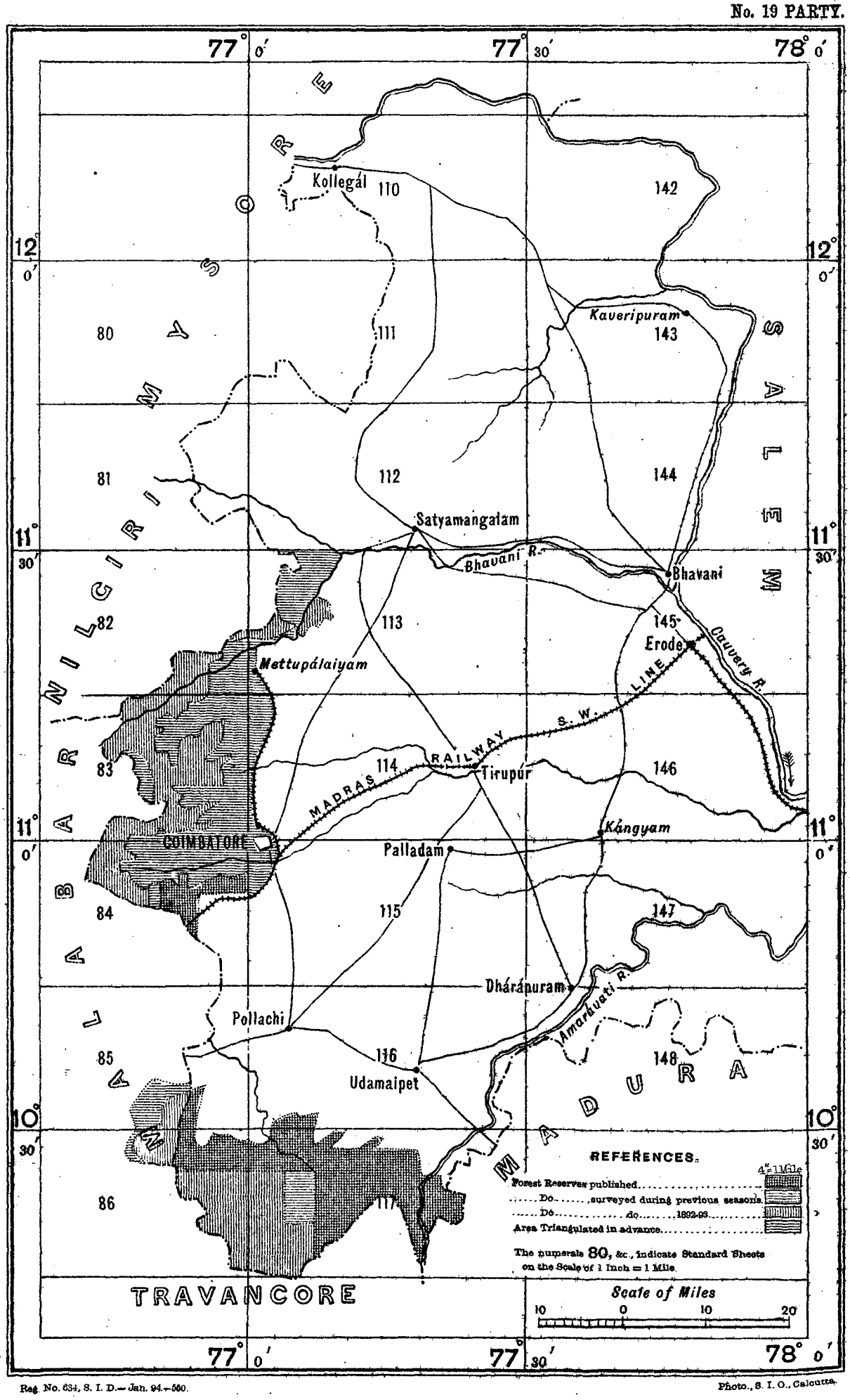

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Photo., S. I. O., Calcutta.

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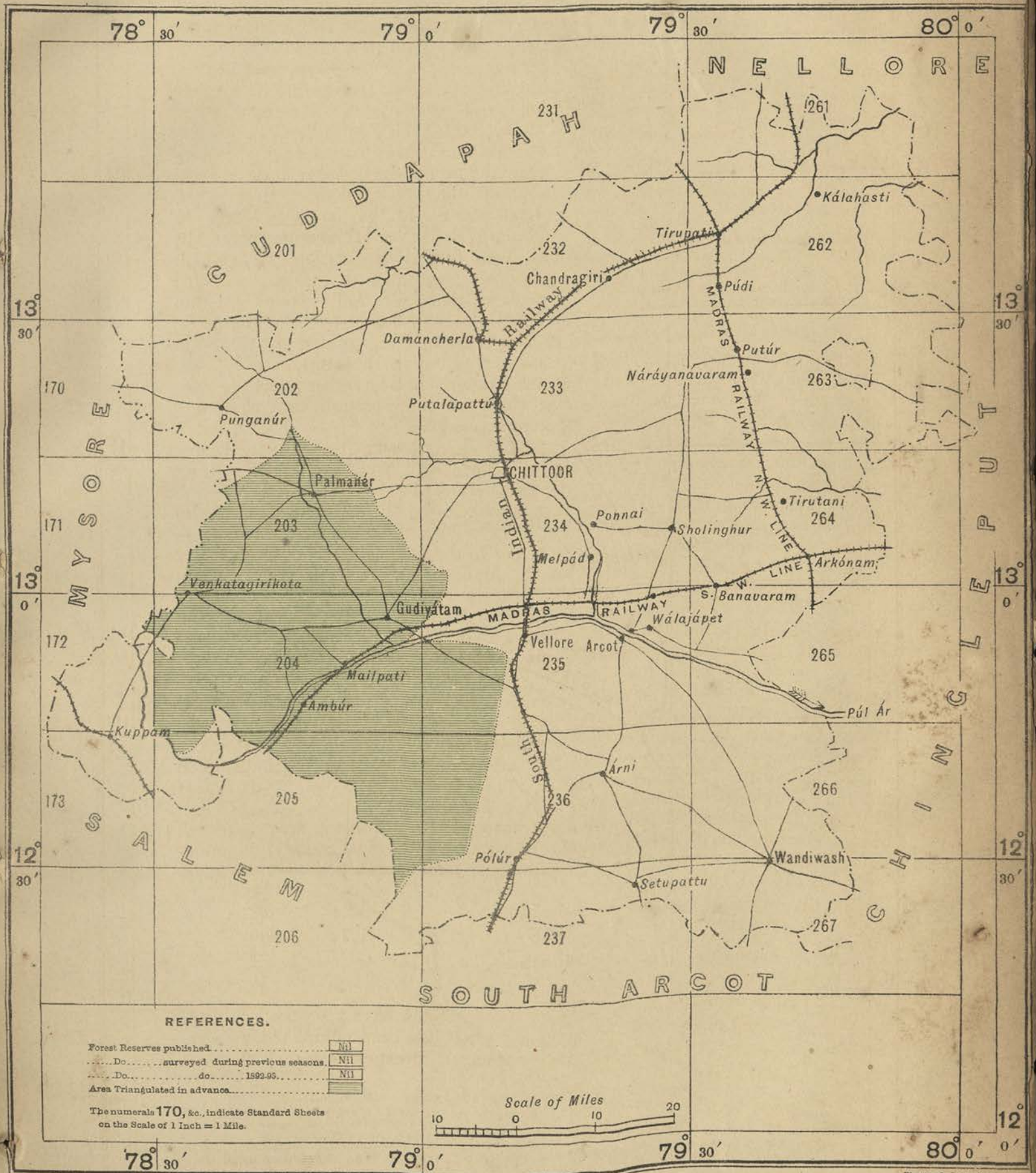
MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE NORTH-ARCOT DISTRICT.

No. 19 PARTY.



Reg. No. 634, S. I. D.—Jan. 94.—550.

Photo., S. I. O., Calcutta.

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state last year, have been well pushed on, and the results of the year's work are altogether satisfactory.*

MADRAS PRESIDENCY.

No. 19 Party.

152. The recess office was closed on the 24th August 1892, and between that date and the end of the month the various sections of the party moved to the localities in which the operations were to be carried on, *viz.*, No. I section under Messrs. R. Todd and Mills to the Salem and Madura districts respectively, to continue the preliminary triangulation; No. II section under Mr. Hamer to carry on the detail survey of the forest reserves in Madura; and No. III section under Mr. H. Todd to perform similar work in Coimbatore. Subsequently that part of No. I section under Mr. Mills proceeded into North Arcot to commence the triangulation of that district; and the whole of No. II section was transferred to Salem to begin the topographical survey of the reserved forests there situated.

Personnel.

Lieutenant-Colonel J. R. McCullagh, R.E., Superintendent, 2nd grade, in charge.
Mr. C. F. Hamer, Extra Assistant Superintendent, 4th grade.
Mr. H. Todd, Extra Assistant Superintendent, 4th grade.
Mr. R. Todd, Extra Assistant Superintendent, 6th grade.
Mr. T. J. J. Mills, Sub-Assistant Superintendent, 2nd grade.

Surveyors and Sub-Surveyors.

T. Raghava Ayengar, Tiruvenkatasami Mudelliar, Lachman D. Jadow, Balaji Dhondiba, Govindaraju Mudalliar, Ramasami Naidu, Anantarao Dhondiba, and 24 others.

153. Field operations were well in hand early in September and were continued till the first week in March 1893, when they were brought to a close and the party returned for recess to Bangalore.

154. In Salem a very large outturn of triangulation has been accomplished, amounting to 1,650 square miles, the areas for North Arcot and Madura being 1,298 square miles and 482 square miles, respectively.

155. The amount of traversing carried out during the season was not very large, in consequence partly of there being a balance in hand from previous years in the Salem district, and partly owing to the boundaries in a good many instances having been laid down by the Madras Survey Department, which saved the labour and expense of fresh surveys.

156. The area topographically surveyed amounts to 788 square miles on the 4-inch scale, the largest outturn so far accomplished, being much above that of any previous year. This is in a great measure attributable to the fact of very little monsoon weather having being felt, and comparatively little sickness experienced, compared with other years, for the physical difficulties which had to be overcome were certainly not less, neither were those connected with labour, transport, or supplies in any way diminished. The country operated in presents varieties of features, from low hills, either isolated or in groups, as in the Madura district, to hills between 4,000 and 5,000 feet in height in Salem and to mountains of still higher elevation in Coimbatore.

157. It is also satisfactory to note that with the increase in area there has been a corresponding decrease in the cost-rates of the final survey, including triangulation and traversing, as the following statement will show:—

				Rs.
In 1888-89	cost-rate	per	square mile	162
„ 1889-90	„	„	„	149
„ 1890-91	„	„	„	112
„ 1891-92	„	„	„	97
„ 1892-93	„	„	„	78

158. During the recess the various computations have been brought up to date; and the fair mapping of the season's work has been completed with the exception of small portions belonging to reserved forests, the survey of which

* Regarding his assistants, Colonel Hutchinson reports as follows:—
"Mr. A. M. Lawson worked well throughout the season and secured a good outturn of 4-inch work in the trying climate of Kanara."
"Mr. S. F. Norman did excellent work, both in Junnar and in Thana."
"Mr. C. A. Norman accomplished a good area of triangulation in a most difficult and trying climate."
"Of the native establishment, I would mention especially the work of Gopal Vishnu, G. R. Bhopatkar and Govind Gopal: these are our most reliable and able men; but the establishment as a whole did excellent work under difficult conditions of ground and climate."

is still in hand. The mapping is included in 42 sheets and comprises 11 reserves, made up of 87 blocksin Madura, 32 reserves in Salem, and in South Coimbatore three complete reserves, as well as portions of two other very large ones, which brings the survey and mapping of this part of the district to a termination.

159. Between the 11th and 14th April the Surveyor-General inspected the recess office of the party at Bangalore. The results of the season's work were carefully examined and found to be very satisfactory. The office records are kept in a methodical and intelligible manner. Lieutenant-Colonel McCullagh deserves much credit for the excellent working order in which this party is now in and which has been arrived at by his unceasing exertions and able management since the party was re-organised for forest surveys.

160. The programme for the ensuing season, which has been approved by the local authorities, comprises briefly the extension of the triangulation and the continuation of the detail survey in the Salem and North Arcot districts.*

LOWER BURMA.

No. 20 PARTY.

161. At the commencement of the year under report, this party was under the charge of Captain Fleming, but on the transfer of that officer to Bengal on the 15th November, 1892, the charge devolved upon Mr. E. J. Jackson, who held it during the remainder of the year.

Personnel.

Mr. E. J. Jackson, Officiating Superintendent, 2nd grade, in charge from 15th November, 1892.
Captain J. M. Fleming, S. C., Deputy Superintendent, 2nd grade, in charge up to 15th November 1892.
Mr. W. A. Wilson, Extra Assistant Superintendent, 2nd grade.
Mr. J. A. Barker, ditto ditto, 5th grade, up to 28th May, 1893.
Mr. R. F. Warwick, Sub-Assistant Superintendent, 1st grade, from 2nd April 1893.
Mr. A. Ewing, ditto ditto, 1st grade.
Mr. H. A. Charrier, ditto ditto, 2nd grade.

Surveyors and Sub-Surveyors.

Venkatswamy, Abdulla Khan, Amjad Ali, Sharfuddin, Moung Kyan Nyein, Moung Hpo Nyein, and 21 others.

162. Operations were carried on in continuation of the previous season's work in district Toungoo, and comprised the survey on the 4-inch scale of reserved forests and on the 2-inch scale of the enclosed unreserved tracts.

163. On arrival of the *khalásis* from India, the establishment proceeded early in December, 1892, by rail to Toungoo, and thence to the several working localities. The detail survey of the Pyu Chaung forest reserve, left unfinished last season, was resumed, and the triangulation and traverse sections were employed in the East and West Swa reserves and unreserved tracts up to the old frontier boundary common to Upper and Lower Burma. On the completion of the Pyu reserve, the detail survey of the East and West Swa reserves was commenced. Field operations were continued till nearly the end of May, when the monsoon set in.

164. The season's outturn was as follows:—

(1) Triangulation was carried over an area of 300 square miles to furnish points by which to check the traverses. A further area of 130 square miles was prepared, but owing to the early setting in of hazy weather the observations could not be taken, and have to be deferred till next season.

(2) Traverse operations covered an area of 402 square miles in the East and West Swa reserves and the intermediate unreserved tracts. The country was exceedingly difficult for chain measurements, necessitating much line-clearing and the stations being very close together.

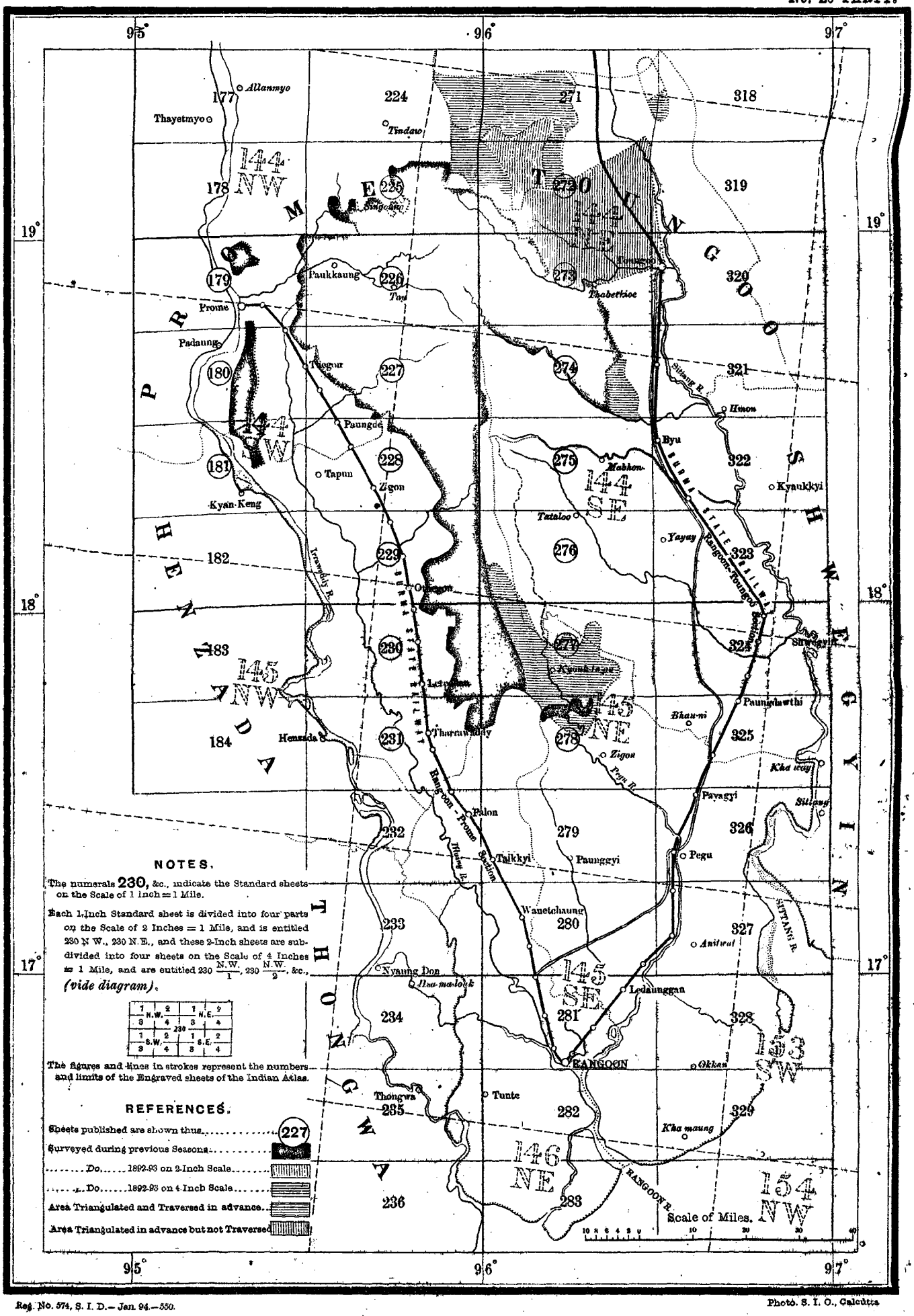
(3) Detail survey of reserved forests on the 4-inch scale covered an area of 232 square miles, of which however 18 square miles was

* Lieutenant-Colonel McCullagh reports very favourably of his European assistants. Mr. Hamer, notwithstanding that his section had to move from one district to another during the field season, succeeded in showing a very good outturn. Mr. H. Todd is always to be depended on to do the utmost that is possible, and to do it with credit. Mr. R. Todd is highly commended for his energy in accomplishing an unusually large outturn of triangulation. Mr. Mills' duties were satisfactorily performed. The surveyors and sub-surveyors are with a few exceptions well spoken of, special mention being made of Raghava Ayengar, Tiruvenkatasami Mudelliar, Lachman D. Jadow, Balaji Dhondiba, Anantarao Dhondiba, Govind Mukund, as well as of the hospital assistant, J. Nathaniel David.

BURMA SURVEY.

INDEX TO THE FOREST SURVEY IN LOWER BURMA.

No. 20 PARTY.



NOTES.

The numerals **230,** &c., indicate the Standard sheets on the Scale of 1 inch = 1 Mile.

Each 1-Inch Standard sheet is divided into four parts on the Scale of 2 Inches = 1 Mile, and is entitled 230 N.W., 230 N.E., and these 2-Inch sheets are sub-divided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled 230 $\frac{\text{N.W.}}{1}$, 230 $\frac{\text{N.W.}}{2}$, &c., *(vide diagram).*

1 N.W. 3	2 4	1 N.E. 3	2 4
1 S.W. 3	2 4	1 S.E. 3	2 4

230

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published are shown thus..... 227

Surveyed during previous Seasons.....

.....Do.....1892-93 on 2-Inch Scale.....

.....Do.....1892-93 on 4-Inch Scale.....

Area Triangulated and Traversed in advance.....

Area Triangulated in advance but not Traversed

Reg. No. 574, S. I. D.—Jan. 94.—550.

Photo. S. I. O., Calcutta

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revision of the previous season's work. Of the intermediate unreserved tracts, an area of 113 square miles was surveyed on the 2-inch scale.

165. The traverses were connected with eight trigonometrical stations and the chain measurements checked thereby. The angular work was checked by observations for azimuth at 96 stations. All the traverse stations were marked with posts four-and-a-half feet in length, of which one-and-a-half foot was embedded in the ground. Zinc plates with numbers in Burmese were nailed to these posts at intervals of half a mile apart. In consequence of constant showers during the early part of the season, and of unusually heavy rain towards the close, the *partalling* and examination of detail survey could not be entirely carried out. However, 78 miles of check survey were run through 26 sections, and the work was found good. The testing of the remaining sections will be taken in hand next season.

166. The country being a mass of low hills, of much the same height and covered with dense forest of trees of great size, the triangulation thereof is extremely difficult. It is found constantly necessary to ascend trees for reconnoitring, and even to make stations of observation on them. To assist the triangulator in this, Mr. Jackson obtained from a marine store dealer in Rangoon rope ladders in lengths of 25 feet each, fitted at either end with hooks and eyes to enable them to be hooked together and so form any length required. In the first instance, a rope has to be taken up to the necessary height by a native, who with the help of irons can climb pretty well any tree in the world. The ladder can then be hauled up and made secure. These rope ladders are in nautical phrase called "Jacob's ladders," and they were found of great assistance in carrying on the triangulation.

167. During the field season there were three deaths, and the average number of men sick from fever was 49 monthly. Fever was also prevalent among the surveyors, and the work was much retarded by this cause and by unavoidable long marches from one reserve to another. Had it not been for the delay so caused, some gaps which have been left in the East and West Swa reserves, comprising an area of 27 square miles, would have been completed on the 4-inch scale. The outturn of detail work notwithstanding shows a small increase of 6 square miles on the 4-inch scale and of 46 square miles on the 2-inch scale over the previous season's outturn.

168. The recess quarters of the party were this year transferred from Rangoon to Bangalore. It was shown that the change would not only benefit the health of the establishment, and so improve the working power of the party, but that it would be an economical step also, owing to the withdrawal of the local allowance while at Bangalore.

169. During the recess, 11 sheets, on the 4-inch scale, partly of the previous and partly of the current season's work, were drawn. The triangulation and traverse computations were completed, and the latter found to agree fairly well with the former, considering the difficult nature of the country traversed. Fifteen plane-tables, containing 33 polygons, of the Swa valley reserves, were plotted for the detail survey next season.

170. The programme for the ensuing season comprises the triangulation of 520 square miles in the Hanthawaddy and Toungoo districts. In the Hanthawaddy district, an area of 378 square miles, and in the Toungoo district, 40 square miles, will be traversed. In the Swa valley reserves, Toungoo district, an area of 289 square miles on the 4-inch scale, and in unreserved tracts of 113 square miles on the 2-inch scale, will be surveyed in detail.

171. The Deputy Surveyor-General in charge of the Revenue Branch inspected the field office at Toungoo on the 2nd February 1893, and the Surveyor-General inspected the recess office at Bangalore on the 18th and 19th September. The general progress of the work was found satisfactory. The field sheets of the detail survey bear the appearance of having been carefully executed and the details as closely surveyed as the difficult nature of the country would admit.*

* Mr. Jackson reports well of the work performed by Messrs. W. A. Wilson, R. F. Warwick, and A. Ewing, and specially mentions the good services rendered by the last named officer.
The native surveyors are also reported to have given satisfaction generally.

CADASTRAL SURVEYS.

BENGAL.

No. 2 PARTY.

172. During the year under report this party was separated into several detachments, working in different localities, chiefly in Bengal proper. Each detachment was under the immediate supervision of an Extra Assistant Superintendent, the whole being superintended by Captain J. M. Fleming, S.C., Deputy Superintendent, 2nd grade, whose head-quarters were located in Calcutta.

173. The operations of the party comprised the following:—

(1) Traverse and cadastral survey in district Chittagong.
(2) Traverse and cadastral survey in district Tippera.
(3) Traverse survey in the Tikari Ward's estates, district Gaya.
(4) Traverse and cadastral survey in the Jaipur Government estates, district Bogra.
(5) Traverse and cadastral survey in the Pataspur estates, district Midnapur.
(6) Traverse and cadastral survey of the Rajapur drainage area, district Howrah.
(7) Traverse survey of the Government estate, district Palamau.
(8) Skeleton boundary survey in the Burdwan estates, district Bankura.

The operations of each detachment will be described separately.

Survey of the Chittagong District.

174. The detachment employed in the Chittagong district continued the traverse and cadastral operations of the previous season: its strength is shown in the margin. Field operations were commenced on the 10th November 1892, and by the end of the season the survey of the district was completed, with the exception of a topographical survey of the hills, which was proceeding in 1891, but was put a stop to by the orders of the Bengal Government after 194 square miles had been completed.

Personnel.

Mr. W. J. O'Sullivan, Extra Assistant Superintendent, 3rd grade.
Mr. C. Graham Lee, Sub-Assistant Superintendent, 2nd grade.
12 surveyors.
8 inspectors.
78 *amins* for the cadastral survey.

175. The season's outturn of traverse survey lay in 87 villages of the Chakaria, Teknaf and Moiskhal *thanas*, Cox's Bazar sub-division, in which an area of 552 square miles was traversed. This area includes 464 square miles of jungle and hills, of which a skeleton traverse of village boundaries was made, showing topographical details on the 4-inch scale. The linear miles of new chaining on the area cadastrally surveyed amounts to 516 and on the boundary survey to 405 miles.

176. Thana Chakaria was divided into two main and five sub-traverse circuits; Moiskhal was included in one main traverse and was divided by a sub-traverse. Portions of these had been surveyed in the previous season. The main traverses followed *thana* boundaries, and the sub-traverses were designed to separate the cultivation from the jungle, to locate the main lines of drainage, and to divide the hills and jungles into convenient sized blocks.

177. To mark the theodolite stations, pottery cylinders locally made were used, and 5,371 of them were embedded. The number of traverse stations is 11,812. The season's survey is mapped on 843 sheets, of which 785 are on the scale of 16 inches=1 mile and 58 are on the 4-inch scale.

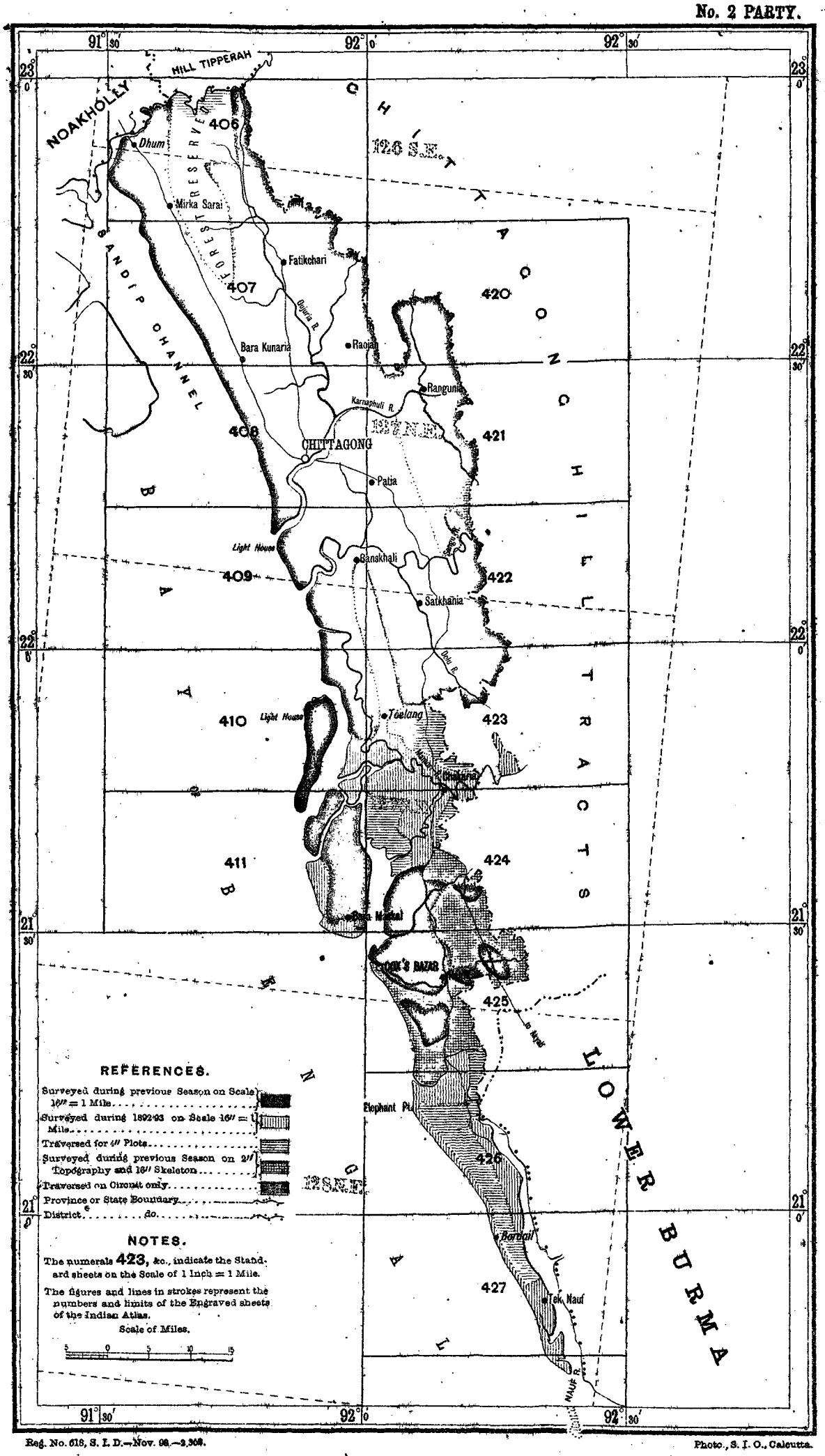
178. The traverse survey was executed entirely by native agency. Azimuths were observed at intervals of 20 or 30 stations apart to check the angular work. The traverses were connected with four stations of the Great Trigonometrical Survey and the chain measurements checked thereby; the average error per mile is 6·27 feet.

The average size of the village is 36·8 square miles. All patches of cultivation were enclosed by traverses to afford stations for the purposes of the cadastral survey.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. CHITTAGONG.

No. 2 PARTY.



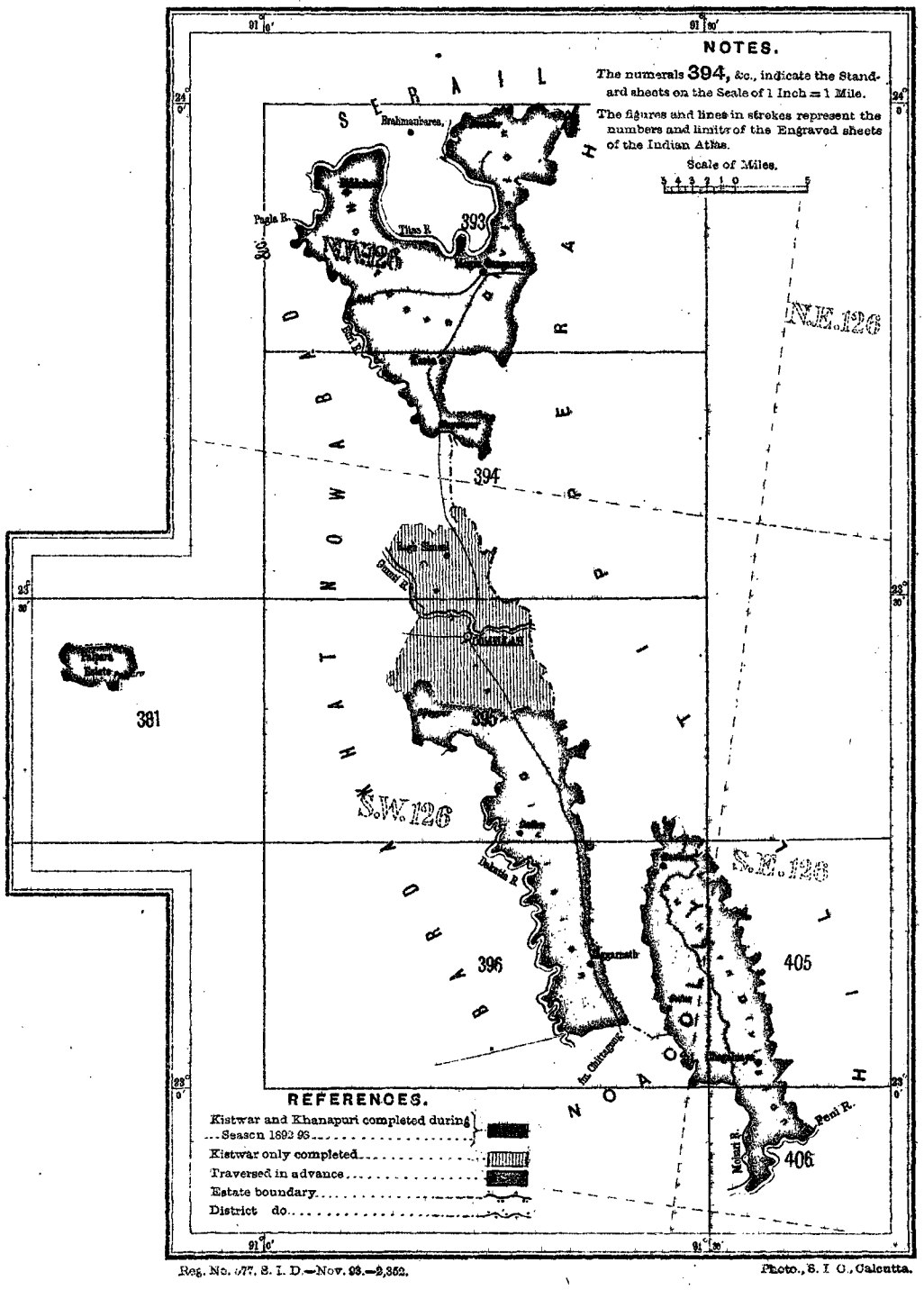
Reg. No. 618, S. I. D.—Nov. 98.—2,308.

Photo., S. I. O., Calcutta.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF CHAKLA ROSHNABAD, DISTRICT TIPPERA.

No. 2 PARTY.



Reg. No. 677, S. I. D.—Nov. 93.—2,352. Photo., S. I. C., Calcutta.

179. The cultivation was mapped on the usual scale of 16 inches = 1 mile, but the boundaries of *mauzas* on the 4-inch scale. The jungle and hills touching on the hill tracts were divided into blocks by order of the Settlement Officer, and will be allotted among villages by him. The traverse surveyor, as he took his observations and chained his lines, recorded boundary offsets in the field books, noting all chain cuttings of streams and other topographical details. The skeleton maps have been prepared with reference to these field books.

180. The outturn for the season is given below :—

Localities.	Traverse survey.		Cadastral survey, 16 inches=1 mile.		
	Number of villages.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Cox's Bazar Sub-division.					
Chakaria	87	124	52	732,273	73
Teknaf		210	15		76
Moiskhal		218	3		10
Totals	87	552	70	732,273	159

181. Mr. O'Sullivan reports that in some cases the areas traversed did not represent what finally turned out to be the villages, as there were so many transfers made at the time of record-writing and at attestation that eventually only a few scattered fields remained of the villages as traversed. The cadastral survey, which was tested by 347 linear miles of check survey, proved to be good, except in a few cases where it had to be re-done.

182. In addition to the above outturn, the survey of the Municipality of Chittagong, which was commenced during the previous season, was completed. In the town considerable revision became necessary, mainly on account of changes having taken place since the survey of the sheets in the previous season.

183. The physical features of the country, the dense jungle, and the extreme distance between the *thanas* under survey were the chief difficulties met with. The health of the party was good, and very different from what it was the previous season when there were so many deaths from cholera. During the season only one *khalási* died, and he was ill when he joined.

184. Traces and area statements of 364 villages, containing 943,277 surveyed fields, were submitted to the Settlement Department during the season. Receipts have been taken from the Settlement Officer for all the survey records which have been made over to him. That officer is now responsible for them.

185. The field sheets have all been inked up and the areas extracted; but work remains to be done in connection with transfers of land from village to village, which will continue while the settlement operations are in progress.

Survey of the Tippera District.

186. This detachment, of the strength noted in the margin, resumed operations in the Chakla Roshnabad estate on the 1st December 1892. The Lieutenant-Governor inspected the office in August 1892, and the following programme was then decided on for the coming season :—

Personnel.

Mr. J. McHatton, Extra Assistant Superintendent, 5th grade.
„ C. G. S. Wood, Sub-Assistant Superintendent, 2nd grade.
„ M. F. Berkeley, Sub-Assistant Superintendent, 3rd grade.
22 sub-surveyors, computers, etc.
22 Hindustani *amins*.
274 Bengali *amins*.
21 inspectors.
2 head inspectors.

(*a*) Completion of the traverse of the remaining 404 square miles.
(*b*) Survey and record-writing of 300 square miles.

187. On the 6th and 7th December 1892 the Director of Surveys and the Director of Land Records and Agriculture held a conference at Comilla, at which the Collector, the Manager of the Roshnabad estate, the Survey Officer, and the Settlement Officer were present. The system on which

the work should be carried on was discussed, and general rules were framed for guidance, the principle underlying these rules being joint control of the Settlement and Survey Officers over a joint establishment for carrying on survey and record-writing simultaneously. Previous to this conference it had been decided that the survey should be done by Hindustani *amins*, and that the record-writing should be done entirely under the control and supervision of the Settlement Officer. The notifications in the Gazette ordering the survey under the Bengal Tenancy Act and the Survey Act are dated 29th November and 13th December 1892, respectively. Orders were also received to include the survey of the Palpara estate in the season's operations.

188. The tract under survey, known as Chakla Roshnabad, comprises the *zamindári* estate of His Highness the Maharaja of Hill Tippera. It is between the parallels of north latitude $\frac{22^\circ\ 5'}{24^\circ\ 0'}$ and the meridians of east longitude $\frac{91^\circ\ 37'}{91^\circ\ 54'}$, the extreme length being about 90 miles and the extreme breadth about 15 miles. The total area of the estate embraced within the present survey operations is 354,416 acres, or 553·77 square miles; but in addition there is an area of about 10,574 acres appertaining to the estate situated in the Sylhet district, which is not included in the present operations. For purposes of management the estate has been divided into three divisions, known as the Northern or Nurnagar, the Central or Meharkul, and the Southern or Khándal divisions, respectively.

189. The following statement shows the outturn of work done during the season:—

District.	Estate.	Traverse survey.			Cadastral survey, 16 inches=1 mile.		
		Number of villages.	Number of traverse stations.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
	Roshnabad.						
Tippera	Northern Division	59	897	52·02	408	244,620	202·02
	Central „	817	7,651	223·83	334	111,360	87·00
Noakhali	Southern „	201	3,384	127·92	...	...	...
Tippera	Palpara	11	176	3·00	11	3,638	3·50
	Totals	1,088	12,108	406·77	753	59,618	292·52

190. The traverse survey comprised 1,944 linear miles of boundary work. In addition to this, 125 linear miles and 684 stations represent the traverses connecting the trigonometrical stations and the Palpara estate, making a total of 2,069 linear miles and 12,892 stations. The area traversed was divided into five main and 28 sub circuits. There are altogether 52 *parganas* in the Roshnabad estate, but the boundaries of these *parganas* are so interlaced that it was impossible to make the main and sub circuits conform with them. In the Northern division 2,899 stations were permanently marked with roughly dressed stone pillars procured from the Bengal Stone Company. In the Central and Southern divisions and in Palpara estate 1,121 stations were permanently marked with glazed pottery cylinders procured from the Raniganj Pottery Works.

191. Traverse work was commenced on the 10th November, on which date nine sub-surveyors broke ground in the Central division, and on the 8th December three more sub-surveyors were sent to the Northern division to complete the traverse of the 50 square miles which remained to be done there. The office moved into camp in the Northern division on the 16th December. The village of Mogra, being the head-quarters of the Sub-Manager, was selected as the

most convenient site for the camp. A few days before the office was moved into camp, Mr. Wood proceeded on a tour of inspection among the sub-surveyors who were then at work in the Central division. The result of his observations and enquiries showed that the slow progress of the traverse work was due to the following causes:—

(*a*) The smallness of the unit of traverse.
(*b*) Passive obstruction on the part of the inhabitants, who could with difficulty be induced to point out the village boundaries.
(*c*) The stone-embedding and line-clearing not having been done in advance.

By the end of March however the whole of the traverse work was completed, and the sub-surveyors were transferred to the Gaya traverse detachment. In distributing the work among the sub-surveyors, the plan adopted was to assign to each man a compact block about 15 to 20 square miles in area, of which he first surveyed the outer boundary constituting a part of the main circuit and then the sub-circuit, observing his own azimuths, and taking special care that all points of junction with the surrounding blocks were invariably adopted by him as azimuth stations. Two independent observations for azimuths were thus secured at all the tri-junctions of blocks, the mean of the results being adopted for checking the bearings. The adoption of this plan enabled the office work to be done more rapidly, as each man's work being complete in itself could be dealt with independently of the others.

192. The angular work was checked by observations for azimuth at 145 stations, the average distance apart being 25 stations. The azimuths were derived from observations to the sun. The reliability of the results derived from sun observations was tested in December last by two independent observations with different instruments, one set of observations being taken to the sun and another set to two stars (east and west), the resulting difference being only 31 seconds. The results of the traverse work were, on the whole, good.

193. The average area of the village circuits is 230 acres, and the average size of the fields 0·52 acres. The sub-traverse stations are situated on the boundaries of fields, there being no sub-division of the villages into *mahals*. The revenue survey maps do not show all the villages which are recorded in the Collector's *mauzawár* register, some being shown separately and some grouped together under one "*thak*." As these *thaks* were considered too large for working purposes, it was decided to adopt as the map unit the *mauza* as shown in the Collector's *mauzawár* register, and accordingly all the sub-*mauzas* were traversed separately.

194. The demarcation of village boundaries was done by the sub-surveyors, who were supplied with the Collector's register and copies of the old 4-inch maps to guide them.

195. The detail survey was checked by 1,172 linear miles of *partal*, 487 miles being by European and "independent *partal*" and 685 miles by native inspectors, thus giving an average per square mile of 1·6 for the former and 2·3 for the latter. Three villages did not pass the test of "independent *partal*," and had to be rejected and re-surveyed. The work on the whole was however good.

196. For the cadastral survey, arrangements had been made to import 50 Hindústani *amins* from Upper India. Three hundred local men (Bengalis) had been under training during the recess of 1891-92, and of these 125 were selected for record-writing by the Settlement Officer early in January. A few of these started work on the 20th January, but it was not till the 1st February that the record-writing was fairly commenced. It had been decided prior to the conference, on the advice of Mr. McHatton, that the survey party was to concern itself with making the survey only, and that the record-writing was to be done solely under the control and supervision of the Settlement Officer, but this plan was set aside as it had not proved a success in Chittagong. The progress of record-writing up to the end of February was very slow. This was due partly to the inexperience of the *amins*, but chiefly to the action of the *kanungos*, who were then working directly under the orders of the Settlement Officer, in refusing to receive the records of the villages that had been completed, because the names of the tenure-holders and *rayats* had not been recorded (as required in Rules 9 and 10 of the rules for

record-writing) in accordance with authorised lists. As the Maharaja's officials were unable to furnish reliable lists of the *taluks*, and as the tenure-holders were obstructive and refused to file their rent-rolls, the work was practically brought to a standstill for fully 20 days. On the 22nd March the Director of Surveys and the Director of Land Records and Agriculture visited the camp, and on the 23rd and 24th March a Conference was held, at which the Collector, the Manager of the Roshnabad estate, and the Settlement Officer were present. It was resolved at this meeting that the procedure agreed on at the Comilla Conference of the 6th and 7th December had not been in operation owing to misunderstanding, and some additional rules were drawn up for future guidance. It was decided that the Survey Officer was to be made solely responsible for the progress of the work, and three of the Settlement Officer's *kanungos* were placed under the orders of the Survey Officer as head inspectors. Rule 10 of the rules for record-writing was also modified. This rule made it incumbent on the *amins* to enter the names of *rayats* in the *khasra* strictly in accordance with the *talukdar's* rent-rolls; but as these lists were not forthcoming and the work was being much delayed in consequence, it was decided that in future these entries were to be made from local enquiries, and that they were to be verified at final attestation. After this the progress of the work was more satisfactory.

197. Owing however to the difficulty experienced in getting local labour, and to the complicated nature of the tenures, the outturn of the Bengali *amins* was far short of what was expected, and it became necessary to increase the number from time to time, till at length there were 274 Bengali *amins* at work. Of this number, 73 were reserved exclusively for record-writing, 46 were employed on survey only, and 155 on both survey and *khanapuri*, each man writing the record of his village as soon as he had finished the survey. The survey of the belt of villages, comprising the hilly tract along the borders of Hill Tippera, was assigned to the Hindustani *amins*, the work here being of too difficult a nature to be entrusted to newly-trained indigenous agency.

198. The progress of the work suffered much, owing to the inclemency of the weather during the months of March and April. On the 22nd March a storm of unusual severity was experienced, which blew down the office hut but fortunately very little damage was done to the records.

199. By the 10th May the survey of the Northern division was completed. The first batch of *amins* entered the Central division on the 15th April, and by the 15th June an area of 87 square miles was finished. The work in the Central division was much hindered by rain, 10 inches having fallen at Comilla during the week ending 6th May. After the 10th May the weather became very warm and sultry. The excessive heat told heavily against the Bengali *amins*, who, being unaccustomed to outdoor work under such trying conditions, showed a marked falling off in their outturn of work. Ten of these men absconded and several others refused to carry on field work any longer, and had it not been for the persevering energy of the Hindustani *amins*, very little work would have been done in the Central division.

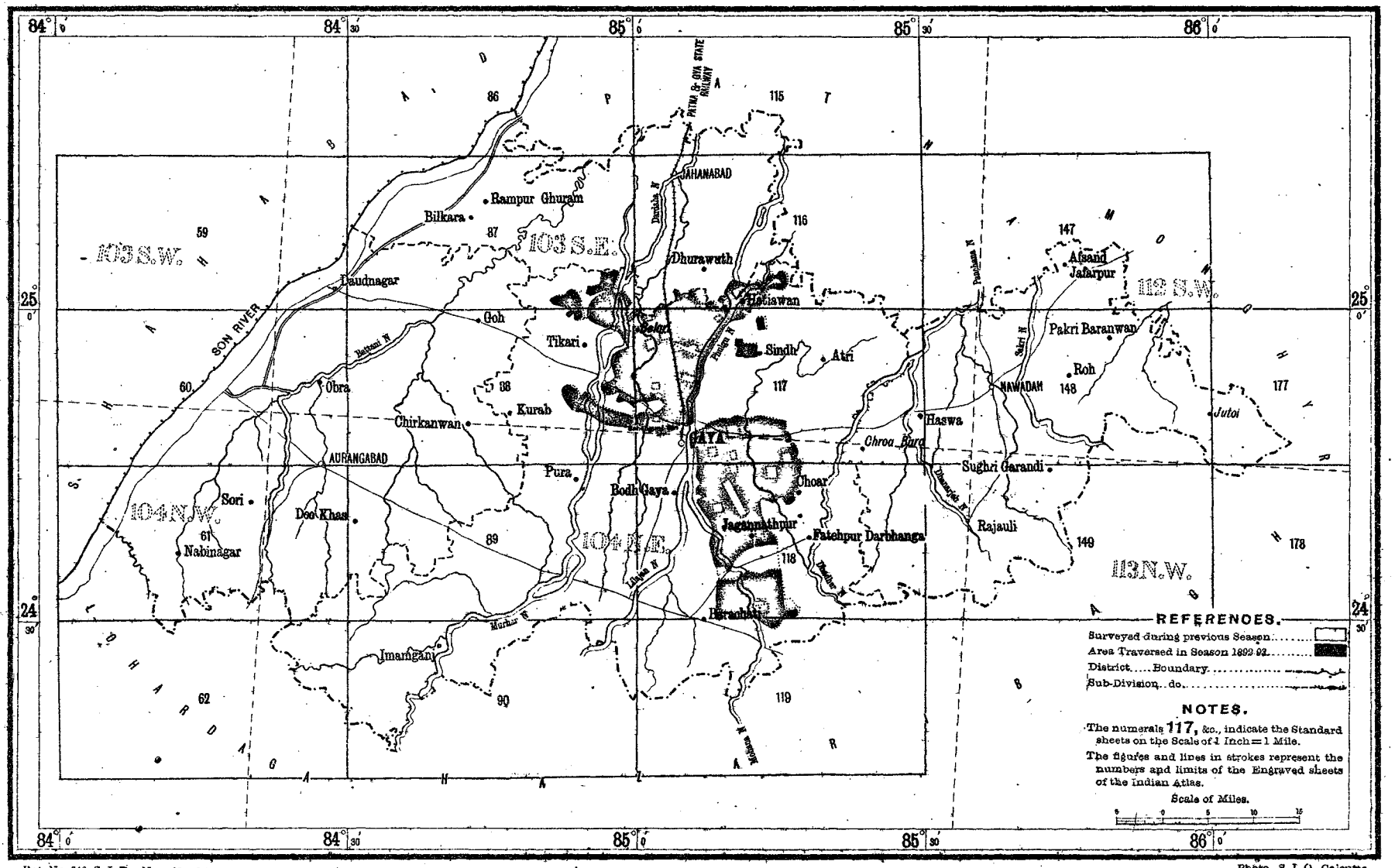
Of the total outturn during the fortnight ending 15th May, *viz.*, 13,306 acres, 8,272 acres represents the work of the 22 Hindustani *amins* and 5,034 acres that of 60 Bengali *amins*. The average daily outturn of the Hindustani *amin* for survey alone was 23 acres and for the Bengali *amin* 6 acres. The average monthly outturn of the Bengali *amin* for survey and record-writing was 100 acres.

200. The record-writing was done exclusively by Bengali *amins*. Owing to the complicated nature of the tenures the progress of the work was slow, and it was therefore necessary to increase the number of *amins* from time to time, till at length there were 228 men employed in this branch of the work. The work was supervised by 14 inspectors (Bengalis) and 3 head inspectors (Bengalis) under the general direction of the Settlement Officer and his *kanungo*, who moved about constantly among the *amins*, checking the work and settling boundary disputes. As already mentioned, the three head inspectors were at first employed as *kanungos* under the Settlement Officer, but they were subsequently placed under the orders of the Survey Officer as head inspectors. Where the survey was done by Hindustani *amins*, all discrepancies found in the boundaries of fields during *khanapuri* were corrected on the map by the *khanapuri amin* in red.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT GAYA.

No. 2 PARTY.



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201. Owing to the early setting in of the rains, the record-writing of the area surveyed in the Central division of the Roshnabad estate could not be done, and this work will have to be included in the programme of the ensuing season.

202. The cost-rates per square mile for each class of work is as follows:—Demarcation and stone-embedding, R29-8; traverse survey, R62-7; cadastral survey, R132-7; record of rights, R125-7.

203. The work has been expensive, which is due to the following causes:—

(1) The high rates prevailing in this district for cooly labour.

(2) The large amounts paid as freight on account of stone pillars and pottery cylinders.

(3) The slow progress of the work, and consequent enhancement of expenditure due (*a*) to the employment of newly-trained indigenous agency, (*b*) the difficulty in procuring coolies, (*c*) the unsympathetic and obstructive attitude of the inhabitants, and (*d*) the complicated nature of the record-writing.

204. There were altogether 108 boundary disputes, of which 91 have been disposed of by the Settlement Officer and 17 are still pending. The disputes were, as a rule, decided on the basis of possession. As all the villages here belong to one estate, the term "village" does not indicate separate ownership, and as the lands constituting the *talukś* are generally scattered in different villages remote from one another, and are very seldom given by entire villages, they cannot indicate any diversity of tenure. The village, then, may be considered as a mere arbitrary unit. There cannot therefore be any boundary disputes in the proper sense of the term; as a matter of fact, these disputes are merely objections on the part of the *talukdars* against having their lands measured in two blocks called villages.

205. An area of 264·75 square miles remains to be surveyed in the Roshnabad estate; and in addition to this there remains to be done the record-writing of 87 square miles in the Central division, of which the survey only was completed during the present season. The survey operations in this estate will be completed next season, and the detachment will be available for transfer on the 1st November 1894.

Survey of the Tikari Wará's Estates, District Gaya.

206. The order of the Government of Bengal authorising the survey under Act V (B.C.) of 1875 of that portion of the Tikari Wards' estates which is situated in *mahals* Sibnagar and Laru, *tauzi* Nos. 5151 and 3160, *parganas* Sanaut and Maher respectively, is contained in the *Calcutta Gazette* of April 12th, 1893.

207. The strength of the establishment is given in the margin. The field establishment was fixed by the Director of Bengal Surveys at 16 traverse surveyors, 12 of whom were transferred from the Tippera detachment and four from the Chittagong detachment. The work was carried on under very disadvantageous circumstances owing to the notification having issued so late. The object of the season's work was to get as large an area as possible traversed, so that plots might be available for the cadastral surveyors to work on at the commencement of the following season.

Personnel.

Mr. L. F. Berkeley, Sub-Assistant Superintendent, 1st grade, in charge.
16 sub-surveyors.
6 computers.

208. All the surveyors joined between 2nd and 11th April 1893. Mr. L. F. Berkeley was transferred from 1st April for the purpose of conducting the traverse survey of the estates, and he was relieved of his duties in the Muzaffarpur district on 26th March. The computing establishment was recruited gradually as the work progressed.

209. At a conference held at Gaya on 4th April 1893, it was decided—

(*a*) that the unit of traverse survey was to be the *mauza* as demarcated by the manager, Tikari Wards' estates;

(*b*) that the Collector of Gaya was to issue notices on proprietors of conterminous villages under section 5, Act V of 1875;

(*c*) that the special notice under section 7, Act V, was to be taken out by the sub-surveyors for issue;

(*d*) that Mr. Berkeley was to send out tri-junction pillars and other cylinders to convenient centres on carts, which the Collector engaged to supply on payment at current rates.

210. The field of operations was entirely in *parganas* Sanaut and Maher of district Gaya. The villages of the Tikari Wards' estates were compactly enough situated to admit of Mr. Berkeley's dividing off the tract for survey into two main traverse circuits and one minor circuit bordering on to main circuit No. 1.

211. The permanent marks used in these survey operations were obtained from the pottery works of Messrs. Burn and Company at Raniganj, and are of two kinds. The cylinders, embedded at the tri-junction points are glazed cylindrical cones marked S. ↑ I., and measure 2½ feet long and are of 8 inches diameter. The ordinary cylinders, embedded at other traverse stations, are glazed pipes 2 feet long and of 2 inches diameter. Altogether 1,492 of the former and 10,000 of the latter were received in three instalments during the field season: many of these were found to be insufficiently baked and glazed.

212. The demarcation was done entirely under the orders of Mr. Angus Ogilvy, the Manager of the Tikari Ward's estates, and his circle officers, by driving wooden posts, 3 feet in height, into the ground at all bends and turns of the boundary, and erecting small mud pillars round them. The field office of the detachment was closed at Gaya on June 23rd, when, as Mr. Berkeley had to make arrangements for the preliminary traversing of the Palamau Government estate, he was ordered to proceed to Daltonganj and to take the Tikari Ward's estates records with him to complete the computations and plotting there. The recess office of the detachment opened at Daltonganj on July 5th.

213. The following is a statement of the outturn of traverse survey during the season for Tikari Ward's estates villages:—

Pargana.	Mahal.	Tauzi Nos.	Villages.	Area in sq. miles.
Sanaut	Sibnagar	5151	194	138·87
Maher	Laru	3160	180	132·21
	TOTALS		374	271·08

214. The area of blocks of villages of other proprietors unavoidably included within sub-circuits (or, in other words, within connecting lines) is as follows:—

Pargana.	Number of blocks.	Area in sq. miles.
Sanaut	20	21·11
Maher	18	18·24
TOTALS	38	39·35

This makes the total area included within main circuits and outlying sub-circuits 310·43 square miles. The average area of each Tikari Ward's *mauza* is 463·88 acres, and the average area of each block 1·04 square miles.

215. Three hundred and fifty-two thousand acres, or 550 square miles, is the total area of the Tikari Ward's estates in district Gaya given by the Manager; therefore 278·92 square miles still remain for traverse survey in field season 1893-94. There are also 5,360 acres, or 8·4 square miles, of the estates in district Patna.

216. The Director, Bengal Surveys, reports that he is particularly indebted to Mr. Angus Ogilvy, the Manager of Tikari Ward's estates, for the way he

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT BOGRA.

No. 2 PARTY.

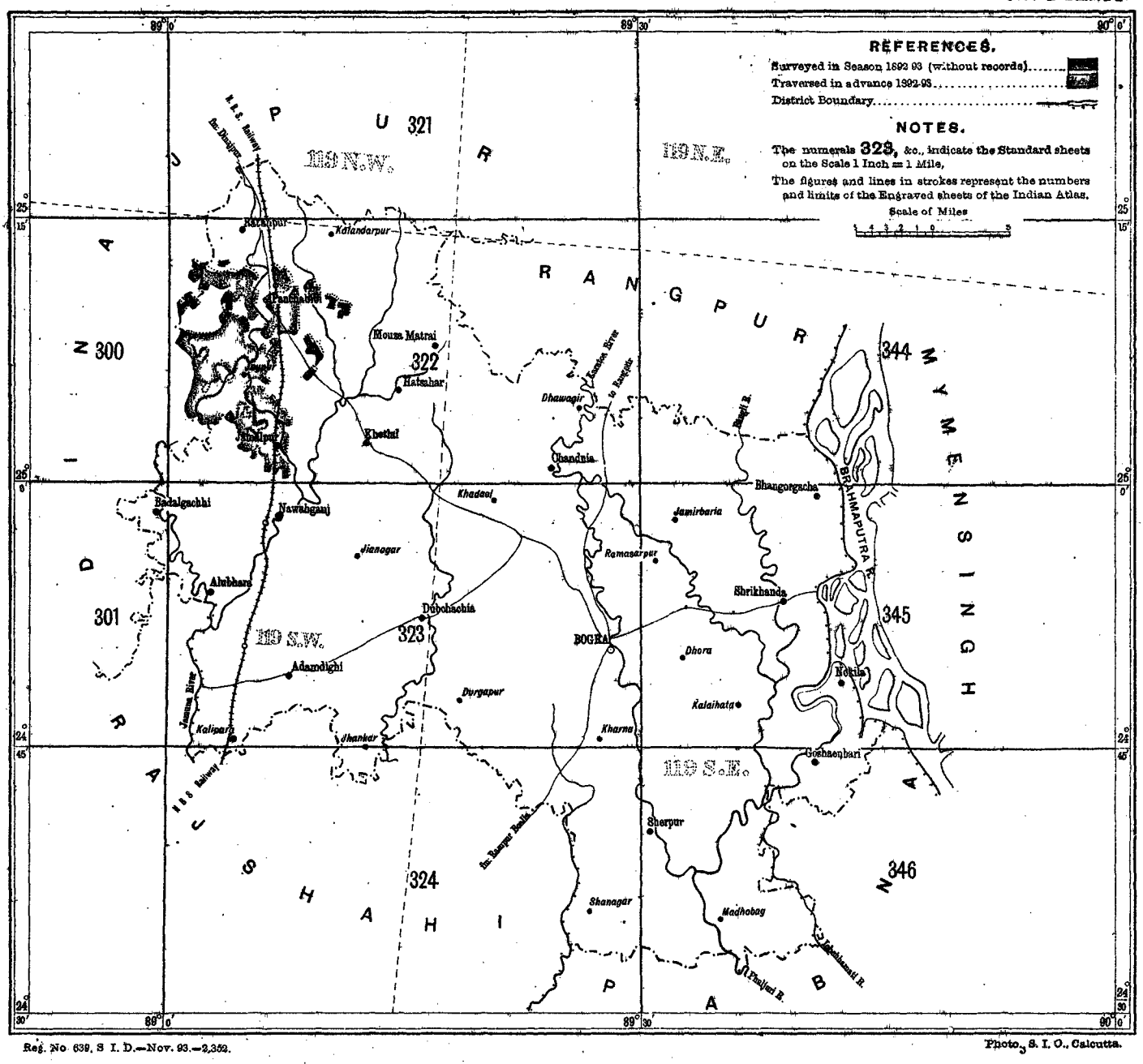

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Photo., S. I. O., Calcutta.

pushed on the demarcation of the estates, for the peons he supplied, and for the order he issued to his circle officers and heads of villages to help the survey in every way. His acknowledgments are also due to the Collector, Mr. D. J. Macpherson, for the help he gave in the way of supplying carts and of putting a stop to obstructions and the taking up of cylinders by *zamindárs* and others.

Survey of the Jaipur Government Estates, District Bogra.

217. On the 17th February 1893 a small detachment, consisting of three sub-surveyors and 25 *khalásis*, was transferred from Burdwan to take up traverse work in Jaipur under Mr. W. H. Penrose. The original strength of the detachment was gradually augmented by the transfer of other available hands and fresh appointments to the strength shown in the margin.

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 4th grade.
„ W. H. Penrose, Sub-Assistant Superintendent, 1st grade.
„ C. G. S. Wood, Sub-Assistant Superintendent, 2nd grade.
7 sub-surveyors.
1 inspector.
22 *amins*.

218. The temporary demarcation, by means of earthen mounds and bamboo stakes, had been undertaken by village *patwáris* under the orders of the Manager of the estates. Much of the line-clearing had also been done by the agency of the people themselves. Yet, as no attempt had apparently been made to render demarcated points intervisible, this help, rendered willingly enough, and good enough, so far as it went, caused no considerable saving of labour or time to the traverse squads. The tortuous nature, too, of the village boundaries, which necessitated the adoption of short lines and a multiplicity of stations, combined with heavy line-clearing through dense bamboo and thorn jungle, for which these parts are noted, rendered progress slow and difficult.

219. The establishment for the cadastral survey was not available till the middle of April, and then, owing to the delay in the arrival of the instrumental equipment from Chittagong, work could not be begun till May. Another drawback which made itself felt all through the season was that the work at the outset was dependent entirely on local labour. Not only was it difficult to obtain any help at all, but even where villagers did aid the *amins* it was not uninterruptedly that assistance was afforded. The Manager of the estates was constantly being referred to; and all reports from *amins* touching the question of assistance were forwarded to the Manager, and he was asked to bring pressure to bear on obstructive villagers or those whose attitude towards the survey was one of indifference. That this was done there is no doubt, and on several occasions Mr. Wood accompanied the Manager when visiting such villages. The *mandals* (or headmen) were made responsible by the Manager for the attendance of the people; but as each of these headmen had under him a circle of five or six villages, many of which, on account of their large area, had two or three *amins* at work in them, it was difficult to provide for each *amin*.

220. The heavy rain which fell in May and June was a serious hindrance to progress. Exposure to the damp and bad drinking-water caused a great deal of sickness amongst the native establishment; and one death (that of a *khalási*) occurred on the 25th May. Fever, bowel-complaints, and a horrible form of scabies were so prevalent that although traverse squads were disbanded with the original intention of employing the *khalásis* with *amins*, no entire squad could be retained. The Manager, in his letter No. 51 of the 8th May, had asked that more *khalásis* should be entertained, as the *rayats* had to devote their attention to their crops. Attempts were made to recruit men locally. Notwithstanding Mr. Wood's efforts, however, and those of the Manager, only two men could be induced to take service, and they were natives of other parts.

221. The notices in Forms A, C, D, which were sent to the Collector of Bógra for signature on the 26th April, were received back on the 14th May, when no time was lost in serving them through the *amins*. This was the best that could be done under the circumstances.

222. On the 16th June orders were received to employ Bengali *amins* on the *khanapuri* of villages the survey of which had been completed. On the earnest representation of the Manager, however, of the hardship to the villagers that would attend the commencement and carrying out of this further stage of the

operations, orders were asked for and received on the 19th June to the effect that the record-writing was not to be taken in hand during the current season.

223. The continued rain, the height of the jute crop, and the unwillingness of the people to turn out because of the damp and the leeches with which the country swarmed, rendered survey work more difficult daily, and Mr. Wood felt justified in reporting by telegram that, under the circumstances, a fair return for money laid out could no longer be expected. Orders were accordingly issued to Mr. Wood to close work, and on the 7th July the field operations were stopped.

224. The number of traverse stations per square mile is 66, which large number must be attributed to heavy jungle and the tortuous nature of village boundaries. The following table shows the outturn of work of each class :—

Class of work.	Area in square miles.
Traverse survey	60·41
Cadastral survey, 16-inch scale	13·15
Demarcation	60·41

225. The number of villaeg circuits surveyed during the season is 173, the average area of each circuit being 0·35 of a square mile, or 224 acres. The number of fields surveyed cadastrally will be correctly ascertained when the *khanapuri* is taken in hand. The number of fields in the 22 *mauzas* surveyed on the 16-inch scale may be set down approximately at 14,000, which gives the average area in acres of each field as 0·6 approximately. The area surveyed in traverse includes 6·61 square miles of land, which, though forming no part of the Jaipur Government estates, for purposes of convenience had to be taken up in survey. This area will not, therefore, come under cadastral survey. In cases where the area of a *mauza* is considerable, a sub-traverse has been run so as to divide the village into convenient blocks; 41 such traverses have been run, but no fiscal divisions have been followed in such traversing.

226. The work has been checked by 65·99 linear miles of *partal*, of which 41·60 was done by inspectors, 14·94 miles by Mr. Wood during progress of the work, and the remaining 9·45 miles was done as "independent" *partal* and compared by Mr. Wood. The average check was thus 5 linear miles in every square mile of country surveyed. The work on the whole may be considered reliable. The heavy checking was done mainly to discover whether *amins* had surveyed *true* fields and not *kotas* (or internal sub-divisions of fields). All sheets surveyed during the season were completely checked. The survey of two *mauzas* and a portion of a third had to be re-done. All sheets were inked up in the fields by *amins* themselves.

227. No field areas have been extracted, as the record-writing has been left over for the coming field season.

228. The permanent marks employed were clay cylinders, burnt and glazed at the Raniganj Pottery Works by Messrs. Burn and Company. Tri-junctions were marked by cone-capped cylinders, $2\frac{1}{2}$ feet long and 8 inches in diameter, and these marks were embedded almost invariably on the actual village tri-junction point: all other stations were marked by cylinders two feet long and two inches in diameter, either on or as near as possible to the village boundary lines. Receipts have been taken from village *patwáris* for all marks put down; and the headmen of villages have been made responsible for their protection.

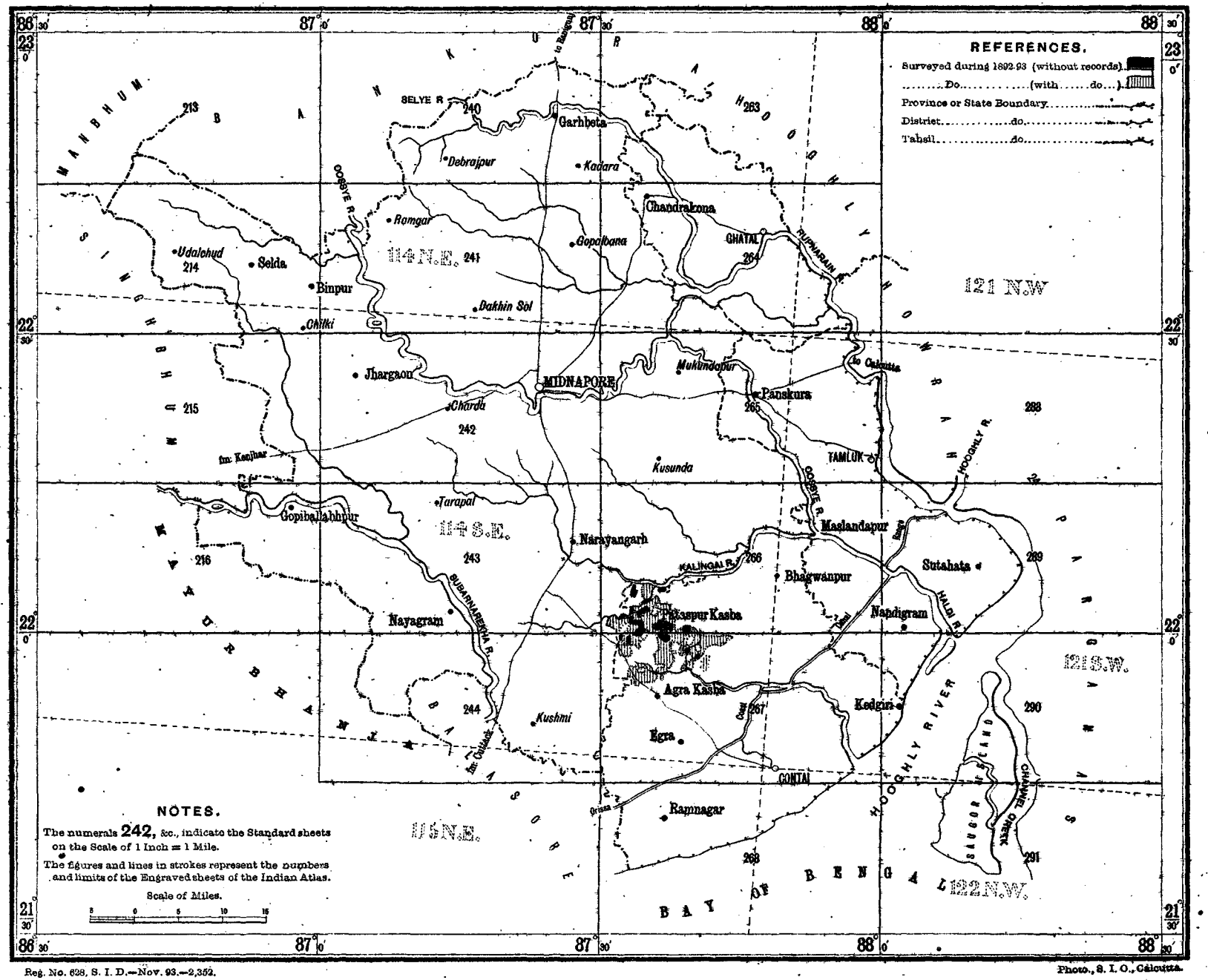
229. Heavy bamboo and thorn jungle along most of the exterior boundaries, as well as many of the interior boundaries, necessitated much heavy line-clearing and much delay. The flat nature of the country, too, with comparatively few streams or *nalas* to drain it, materially aided inundation when the rainy weather set in and caused the water in the *jhils* to rise. As in the adjoining estate of Shankarpur, the general attitude of the village people towards the survey was one of indifference or passive obstruction. It was only through the Manager's influence that they could be induced at all to attend sub-surveyors and *amins*; and in many cases entire ignorance was pleaded regarding information as to boundaries or holdings.

230. The demarcation done by *patwáris* under the Manager of the estates was begun early in 1893, and was almost completed when the traverse survey

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT MIDNAPORE.

No. 2 PARTY.



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was undertaken. Only one dispute of any importance was met with. A double line of stakes and earthen mounds was erected, and both were surveyed Traces on the 4-inch scale of the old revenue survey maps, of 1859-60, which had already been compared with the *thakbust* maps, were supplied to sub-surveyors as a guide. Village boundaries as demarcated or pointed out on the ground were found to agree very fairly with these traces.

Survey of the Pataspur Estates, District Midnapur.

231. A notification appeared on the 25th October 1892 that, "under the powers conferred upon him by section 101, sub-section (2), clause (*d*), of the Bengal Tenancy Act, VIII of 1885," the Lieutenant-Governor is pleased to order a survey to be made, and a record of rights prepared, in respect of all lands in the temporarily-settled estates in *pargana* Pataspur, district Midnapur.

232. A detachment as detailed in the margin was provided for this work, and Mr. Campbell left Calcutta for Midnapur on 20th December 1892 for the purpose. The whole of the Pataspur estates have to be surveyed afresh. But the orders were that all previous theodolite survey stations which were found should be connected upon. The area for survey was 57 square miles, and comprised 18 *zamindáris*.

Personnel.

Mr. G. Campbell, Extra Assistant Superintendent, 6th grade, in charge.
4 sub-surveyors.
4 inspectors.
50 *amins*.

233. The field was taken during the first week of January, and the traverse work was practically done about the middle of March. The number of linear miles of boundary survey done was 385. The circuit followed the sinuosities of the boundary as far as possible (the boundaries were marked with bamboos and later on with mud pillars, as pointed out by the village headmen), the territorial sub-divisions or *parganas* were intermixed, besides which several permanently-settled villages were interlaced with the temporarily-settled ones, and small *chaks* of temporarily-settled lands were incorporated within the area of settled villages, rendering the difficulty and expense of surveying them out of all proportion to the return of work. The number of permanent marks embedded were at tri-junction points 569 pillars and at other stations 1,179 clay pipes.

234. Very little assistance was obtained everything was promised, but very little done by the *zamindár's* agent. On arriving at the scene of operations at Pataspur, it was found that there were no land marks whatever, except where the Settlement Officer had induced the people to put up bamboos as a temporary measure. It was found that there were only two classes of people through whom the erection of boundary pillars could be effected. These were, first, the *patwáris*, of whom in the Pataspur estates there were only 22, for the supervision of 92 villages; further, the villages of a given *patwárship* were often not adjacent, but, for some reason, scattered over the entire *pargana;* the *patwári* was, therefore, usually conspicuous by his absence. Secondly, the village headmen, called locally *barawas*: these men, whose lands were favourably assessed in consideration of rendering assistance to the *zamindárs* during the former settlement, did help to a certain extent during the present survey. As there was much difficulty in getting the village people to mark their boundaries, it was arranged with the Settlement Officer to get a very few villages demarcated at a time in order to give the traverse surveyors work.

235. In respect to the field-to-field survey, the number of villages surveyed was 92, covering an area of 57 square miles, and the average area of each village being 0·62 of a square mile. The number of fields surveyed was 97,000, and the average area of each field 0·38 of an acre.

236. The features of the country presented two marked contrasts. The outlying portions of village lands, for the most part, comprised large, open, rectangular rice-fields, easily measured, except in swampy places where no ridges existed. On the other hand, the village sites which are densely crowded with bamboos, were most intricate and difficult to map, even by old and experienced *amins*. The requirements of the Settlement Officer, too, made this survey the more difficult, as that officer pointed out that in Pataspur it was required that the houses should be assessed at different rates from the homestead plots adjoining them, some of which were exceedingly small.

237. In a great many cases it was impossible to get either the *baráwas* or under-*rayats* to point out their fields, the more so as in and around the Pataspur estates it is common for a cultivator to live in one village and cultivate in another, and knowing that they would have to be called in for the record-writing, they avoided being present at the time of measurement. To save time, therefore, *kiaris* were often measured, and then, on the completion of a village, by special notice, the cultivators were called in, and, as pointed out by them, the "iles" or ridges between common plots were marked with a small cross and the limits of the true fields inked up. Under the pressure of circumstances this was found to be the only method practicable.

238. The amount of independent *partal* was 3,461 chains: the amount of inspectors' *partal*, 9,051 chains. The average amount of *partal* per square mile of survey was as follows: independent, 60 chains per square mile; and by inspectors 159. This average applies to good work. Of bad work, three villages were completely re-surveyed, and many portions of others, when found inaccurate, were re-measured; besides which, several village sites were, for the most part, examined, map in hand, *in situ*, by which means errors were often found that would have escaped the *partal* lines.

Survey of the Rajapur Drainage Area, District Howrah.

239. The survey of the lands reclaimed under the Rajapur drainage scheme had been started in the season of 1891-92 under the orders of the Collector of Hooghly without professional control by Mr. James Todd, a pensioned surveyor of the Survey of India Department. As the work in that season was not successful, the Collector requested the Director of Bengal Surveys to undertake the superintendence, which was agreed to. The tract covers an average width of 7 miles, and extends in a northerly direction from close to Ulubaria to Chanditola thana.

Personnel.

Mr. James Todd, pensioned Surveyor.

Temporary.

5 sub-surveyors.	3 computers and writers.
5 inspectors.	4 estimators.
56 Bengali *amins*.	10 *muharrirs* and others.

240. The field work was placed in immediate charge of Mr. Todd, who proceeded to the scene of operations at Sijberia, district Howrah, on the 15th December 1892. The sub-surveyors started work somewhat later. The establishment of *amins* was completed on the 28th March, as plots showing positions of theodolite traverse stations were available for filling in internal measurements.

241. The survey has been cadastral, on the scale of 16 inches=1 mile. The object of the survey is to enable the Commissioners of the Rajapur drainage scheme to ascertain the extent, nature, and proprietors of such lands as have benefited by the scheme, with a view to assessment in proportion as the lands have become more valuable by the drainage system lately completed.

242. When the Drainage Commissioners started survey work under their own arrangements, the area to be dealt with was estimated at 54 square miles. At the end of season 1891-92 they stated that the area was found to be underestimated, but to what extent they were unable to say. In the preparation of estimates in the Survey Office, the area traversed during 1891-92, *viz.*, 15 square miles, was taken as representing the excess area, leaving 54 square miles to be traversed and surveyed in detail during season 1892-93. Estimates were consequently framed and establishment recruited for only 54 square miles. At the end of the field season, on 1st July 1893, it appeared that the Department of Public Works had contoured the country, extending over an area of about 99 square miles altogether. Omitting 15 square miles previously traversed, the area to be dealt with during the season under report thus turned out to be 84 square miles instead of 54, for which estimates were framed.

243. The actual limits of the lands to be surveyed not being known at the time of starting traverse work, no main circuit was surveyed enclosing the whole area, as would have been done according to the ordinary departmental procedure. As soon as blocks of villages were demarcated these were allotted to sub-surveyors, who enclosed them by traverse circuits which have been denominated sub-circuits. Traverse work may be said to have started on 1st January 1893. Prior to this the Public Works Department had been erecting

BENGAL SURVEY.

RAJAPUR DRAINAGE SURVEY,

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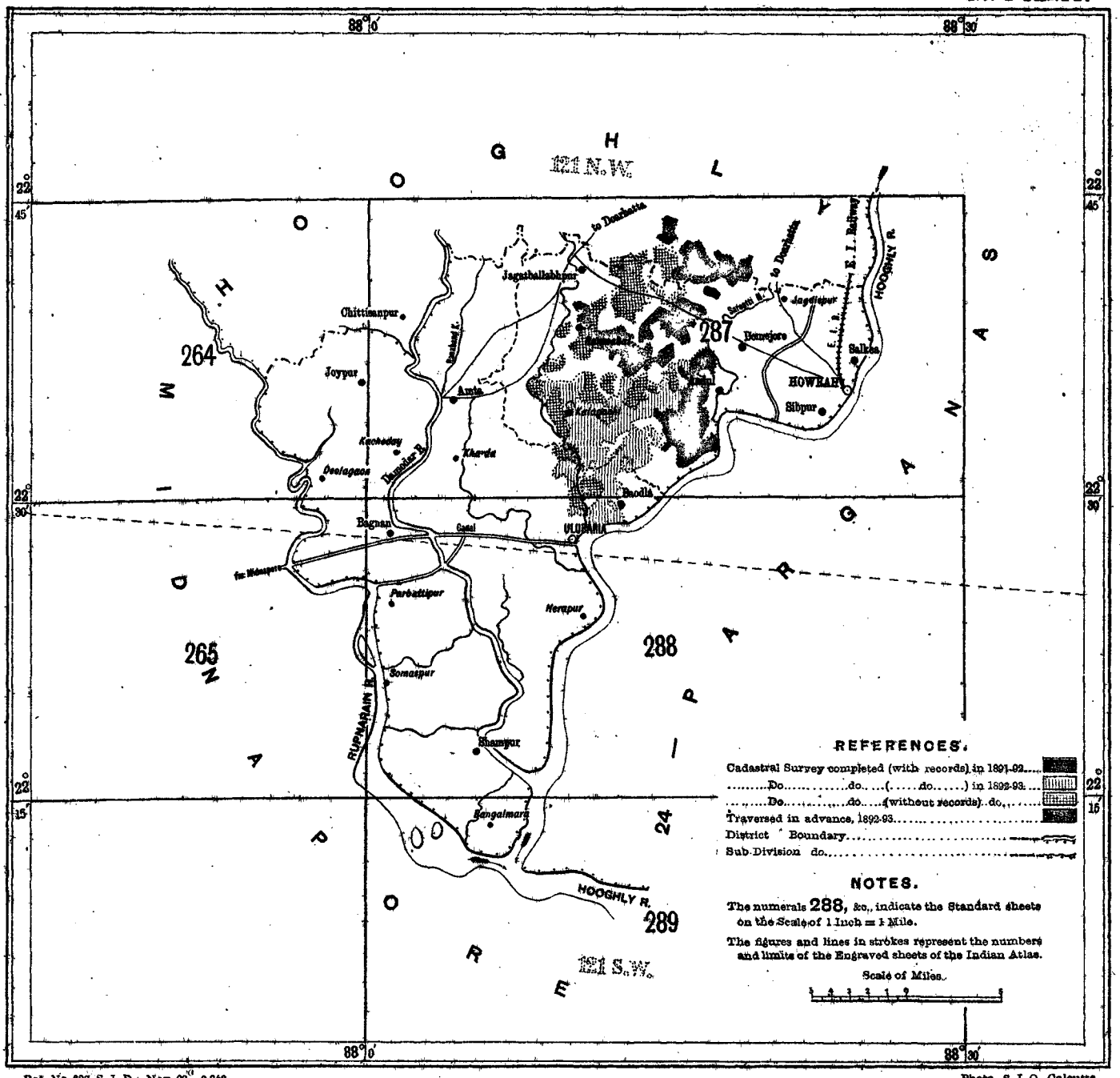

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Photo., S. I. O., Calcutta.

pillars at the south of the tract to be surveyed, and not contiguous to the lands measured during the previous season: this caused some inconvenience, as traverse work had of necessity to be started in continuation of the villages previously surveyed. On a representation being made to the Executive Engineer this was remedied, and the sub-overseers and sub-surveyors eventually worked together in the same tracts till the erection of contour pillars eventually preceded the traverse survey.

244. During 1891-92 the traverse lines were carried along the contours irrespective of the *mauzas* in which lands were situated: this appeared objectionable for many practical reasons, so during the season under report the theodolite stations were placed along *mauza* boundaries. Where the *mauzas* were large, internal theodolite stations were placed as close to contour lines as practicable. The boundaries of *mauzas* were actually marked on the ground during this season, whereas during the previous year they had to be traced up, subsequent to survey, by the aid of the *thakbust* maps.

245. As during the course of the season the original area marked out for survey was found to be gradually increasing, more sub-surveyors were sent to assist in completing the work; but owing to the unusual rains an area of about 9 square miles, which had been contoured, remained over for traverse on the 1st of July, when further work in the field was found impossible.

246. The outturn of traverse work during the season under report is—

District.	Number of villages.	Number of traverse stations.	Linear miles of chaining.	Area in square miles.
Howrah (Rajapur Drainage Survey)	140	2,914	379	76

247. The survey undertaken for the Rajapur drainage scheme will be of no use for bringing the topographical and other details of the existing district maps up to date, inasmuch as only those portions of *mauzas* have been surveyed which fall within the tract known as the "benefited area," and these portions consist solely of cultivated lands. There thus exists no necessity for fixing the exact geographical positions of the lands surveyed, and consequently the traverse work has not been connected with any of the stations of the Great Trigonometrical Survey.

248. According to present estimates, only 14 villages having an area of 9 square miles remain for traverse survey; but as nobody seems to be acquainted with the exact extent of country which will fall within the assessable limits, these figures may eventually prove to be under-estimated.

249. When traverse work was started during the season under report, it was intended that all theodolite stations on the boundaries of *mauzas* should be marked by glazed pottery pipes of 2 inches diameter from Messrs. Burn and Company of Raniganj: as a first instalment, 1,500 pipes were obtained for the purpose. The Drainage Deputy Collector, who was co-operating in the work on behalf of the Drainage Commissioners, objected to any more being obtained on the score of cost, as well as to the absence of necessity for permanently marking the traverse stations of a survey made for a purely temporary purpose. He argued that, as no investigation into boundaries or proprietory rights was to be made, the placing of permanent marks would in no way benefit the Drainage Commissioners, although it might be useful from a professional survey point of view as well as to *zamindárs* hereafter. Early in June, when it became apparent that the whole of the villages traversed could not be completed in detail measurement, 550 more pipes were obtained to mark the theodolite stations on *mauzas* which would have to be surveyed cadastrally during the coming season. The work of embedding these 550 pipes was taken in hand as soon as practicable, but, owing to the country being under water, there still remained about 100 stations unmarked at the end of July.

250. The detail survey commenced nominally on the 1st January 1893 in eight villages which had been traversed during the previous season; but owing to the swampy nature of the country, uncut crops, and want of attendance of

zamindárs, little or nothing was done till the 20th January. Measurement of the newly-traversed lands was commenced on 1st February by 10 *amins*. Skeleton plots were prepared gradually during March, at the end of which the whole establishment was at work for which estimates had been prepared.

251. With the exception of eight Hindustanis (who struck work after being a couple of weeks in the field) the *amins* were all Bengalis, the majority of whom had previously served with professional survey parties. As cadastral survey operations in Bengal proper have been somewhat intermittent, the supply of Bengali *amins* trained in the professional methods of measurement is limited; consequently a certain number of men with previous experience in local settlement operations had to be entertained and trained before being entrusted with measurement work.

252. The unit of measurement was the "field," that is to say, the plot separately assessed to rent under existing arrangements. *Kiaris*, or sub-divisions of fields made for convenience of cultivation, were not shown on the maps.

253. Instructions for preparing the records to suit the requirements of the Drainage Act were drawn up by the Drainage Deputy Collector in conjunction with Mr. Shaw: these were printed and translated into Bengali for use by *amins* after final approval by the Collector and Director of Surveys, Bengal. The main points of difference between the *khasra* adopted for Rajapur and that in general use for settlement purposes in Bengal is that no entry of crops is necessary, nor of irrigation, the division of lands into three distinctive classes according to elevation above sea-level taking its place. No *khatians* were prepared, the *parchas* (in foil and counterfoil) being considered sufficient.

254. The *amins* were under the joint control of the Drainage Deputy Collector and Mr. Todd. The Drainage Deputy Collector, under whom was placed a Sub-Deputy Collector, had the more immediate supervision of the writing up of the *khasras* and *parchas*, although these were tested by the inspectors under Mr. Todd's control. All arrangements for attendance of villagers and testing the various entries were made by the Sub-Deputy Collector.

255. The detail survey was checked by 93 linear miles of test work by Mr. Todd, by inspectors, and "by independent *partal*" or re-surveys made after the maps were lodged in the camp office. In April 1893 the Drainage Deputy Collector complained of certain errors discovered in the detailed measurements carried out during the previous season under supervision of the local authorities. In consequence of this complaint, and to ensure a perfectly independent check on the detail survey of the season under report, Mr. W. H. Penrose was deputed to carry out test surveys in all villages measured up to date of his arrival at the scene of operations. Mr. Penrose was employed for one month testing the work and inspecting *amins* while they were measuring. Altogether Mr. Pensore ran 21·5 linear miles of check survey, with the result that two sheets of a very large village were rejected as incorrect, the remainder of the work having been found equal to professional requirements.

256 There is no information at present forthcoming to show the percentage of *khasra* entries tested by the Drainage Deputy Collector and the Sub-Deputy, as the responsibility wholly rests with them.

257. The outturn of detail survey and *khanapuri* for the season is—

District.	Cadastral survey, 16 inches=1 mile.				Khanapuri.		
	Number of villages.	Number of fields.	Average size of fields in acres.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.
Howrah	92	32,338	0·85	43	51	21,743	29

258. After the field work was stopped on the 1st July, Mr. Todd's services were no longer considered necessary for carrying on the small amount of office work which the season's outturn required. A small establishment was therefore placed under the Drainage Deputy Collector and located at Hooghly, the office being occasionally inspected by an Extra Assistant Superintendent of Survey. The traverse computations were completed in the Survey Office at Calcutta.

The field areas and offsets were estimated at Hooghly and the results forwarded to Calcutta, where their accuracy by the summation of fields was tested by comparison with the area calculated by the universal theorem. Owing to intricacy of offsets and sub-division of "fields" by contour lines, the field areas had to be rejected in numerous cases, and the completion of areas consequently dragged on more slowly than was anticipated.

The completion of the *khasras* and *parchas* was delayed by the want of passed areas. At date of report however only six villages remain to finish the season's work, and these will be finished long before the Drainage Deputy Collector is in a position to start his attestation and local enquiries.

259. As happened during the previous year, the landlords had to be forced to render information regarding their boundaries, etc., and in no single instance can assistance be said to have been given spontaneously.

260. The Drainage Deputy Collector was very energetic, during the season, in his inspection of the field establishment, and did his best to assist in furthering the interests of the Drainage Commissioners.

Survey of the Palamau Government Estate, Chota Nagpur.

261. The notification of the Government of Bengal authorising the survey of the Government *khalsa mauzas* of the Palamau Government estate in the district of Palamau appeared in the Gazette of 1st August 1893. It is No. 2725 L.R. under section 3 of Act V (B.C.) of 1875.

262. The estate contains 383 villages, covering an area of 273,635 acres, of which it is estimated that 70,000 acres, or about 110 square miles, are cultivated and require to be surveyed in detail.

Personnel.

Mr. L. F. Berkeley, Sub-Assistant Superintendent, 1st grade in charge.
Narain Pershad, sub-surveyor, from 21st July 1893.
Abdul Karim, sub-surveyor, from 21st July 1893

Temporary.

Abdur Rahman, traverse surveyor, from 21st July to 21st August 1893.
Hatim Ali, traverse surveyor, from 1st September 1893.
Azimuddin, traverse surveyor, from 8th September 1893.

263. The strength of the establishment detailed for the survey is given in the margin. All the surveyors were transferred from the Gaya survey from the dates given opposite their names, and the operations during the season under report were restricted to the preliminary traverse survey.

264. The field of operations during the season was in *tappas* Pundag, Kote, Tallia, and Goawal. The country could not possibly be divided off into main traverse circuits, as the villages are disconnected and only cultivation and boundaries within cultivation are being traversed just now. The traversing has all been continuous and connected, and 18 azimuths have been observed up to date along it. The observations for azimuths have been chiefly taken to the sun, as it was very difficult to distinguish stars in the rainy months, when it remains cloudy so constantly.

265. The following statement shows the traverse outturn of the season:—

Serial No.	Name of *tappa*.	Number of villages.	Area in square miles.
1	Pundag	34	14·72
2	Kote	13	12·03
3	Tallia	5	5·70
4	Goawal	4	5·25
	Totals	56	37·70

266. In most of the villages surveyed the old masonry tri-junction platforms have been found, some of them being in a very broken condition, and in such cases a stone locally picked up and cut into triangular shape has been embedded in the centre of the broken platform: all other intermediate stations have been marked with locally picked up and uncut stones; but as a distinguishing mark a circular hole has been cut in the centre of them, over which the theodolite is plumbed. No stone masons have been employed, as they could not be got under

Rı2 a month each. the *khalásis* locally engaged do all the cutting that is necessary.

267. The cultivated area remaining for traverse may be put down roughly at 72·30 square miles; but it will probably be more, and the area remaining for boundary traverse may be put down roughly at 395·30 square miles. It is anticipated that the boundary traverse of all villages that the Deputy Commissioner has applied for will entail a good deal of trouble, and if the boundaries are not all cleared beforehand the sub-surveyors will be delayed.

268. The season has been very feverish and unhealthy, and the health of the traverse surveyors has been very bad indeed in consequence. It is hoped that the winter months will not be quite so bad, even when the traverse surveyors get down to the southern *tappas*, which are said to be very feverish.

Survey of the Burdwan Estates, District Bankura.

269. The Burdwan Raj detachment continued the operations which it had commenced the previous season and which had remained unfinished.

270. The programme consisted in the completion of the traverse and skeleton boundary survey of the lands pertaining to the Burdwan Raj estate, which had not previously been measured. The areas expected to come under the different operations were—

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 4th grade,
„ A. B. Smart, Sub-Assistant Superintendent, 2nd grade,
7 sub-surveyors.
18 computers and others.
4 inspectors.
42 *amins*.

	Square miles.
Traverse	100
Skeleton 4-inch boundary survey ...	670

The above areas proved however to have been somewhat under-estimated, as will be seen from the final return given further on.

271. As the objects of the survey have not been specifically stated in previous reports, it may be as well as to state them here.

The objects of the present survey are to ascertain—

(1) who are in possession of Raj lands, be they *khas* or *patni*, in the entire district of Bankura;
(2) what villages are in possession of each *patnidar* in each "lot" this is necessary, as the lands are leased by "lots;"
(3) the positions of lands forming each *patni* lot, to permit of a comparison between entries made at time of the *thakbust* survey of 1854 and those made at the present survey, and the connection traced between present *patnidars* and those formerly registered;
(4) discovery of occupants of lands in lot Golakpur, Bhelera and Chaitanganj, as well as the 312 villages not covered by *patni* leases in *tauzi* No. 1; as also of the 201 villages of *tauzi* No. 2, which are probably in illegal possession of *patnidars* or others;
(5) the whereabouts or positions of lands which ought to be under *khas* management but which are not.

The result of the survey will be that the management of the estates will know in what manner the whole of the Bankura properties are disposed at date of survey.

272. The following statements are under preparation to enable the Raj to assert its rights:—

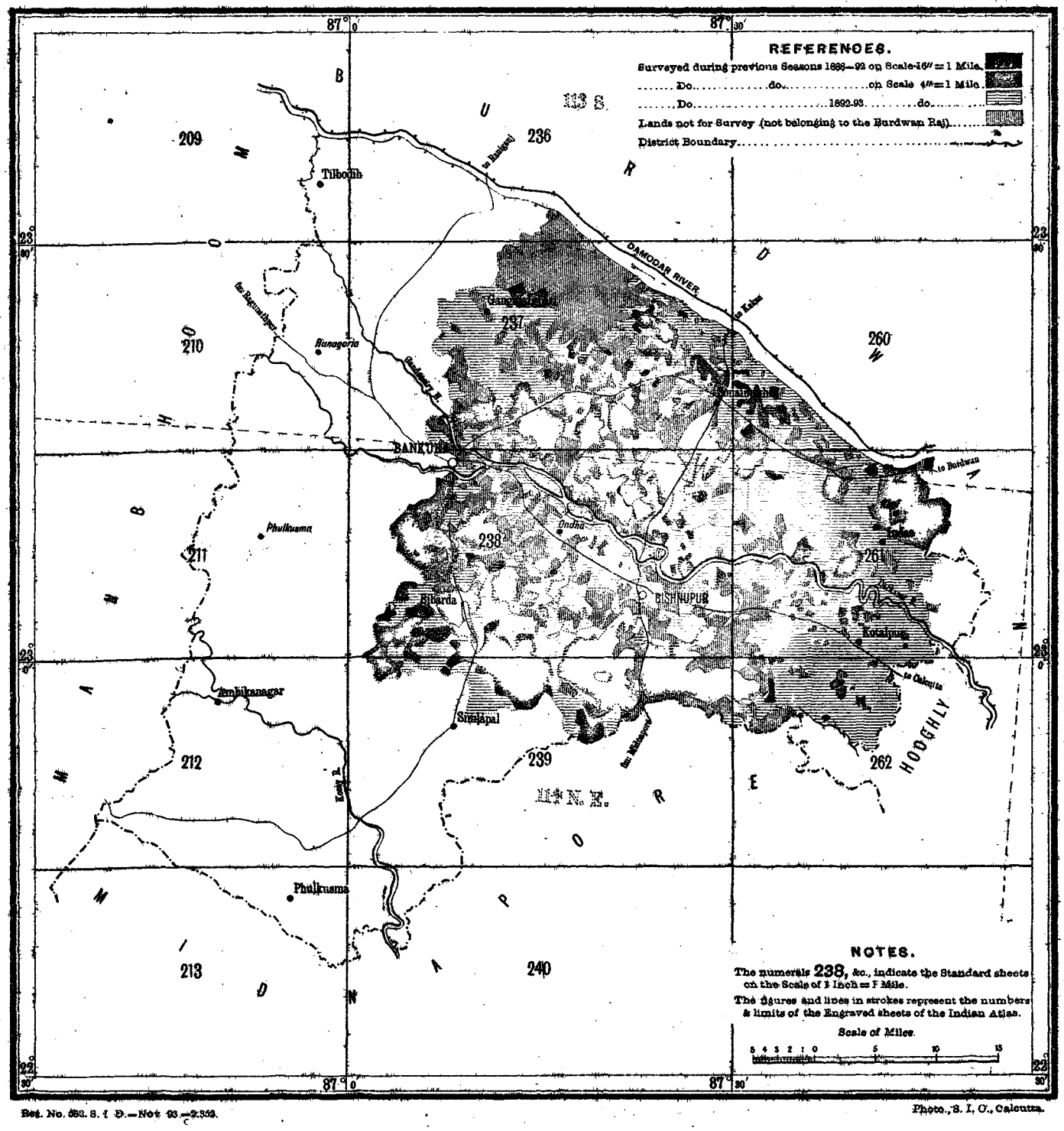
(*a*) Maps on the 4-inch scale of all villages, other than *khas* villages, in *tauzis* Nos. 1, 2, 3, and 4.
(*b*) Records to accompany, showing persons in possession and nature of tenures claimed.
(*c*) Villages grouped into *patni* "lots" from above records.
(*d*) Lists showing excess lands held by each *patnidár* over and above those returned by him to the road-cess office.

These statements will enable the Raj authories to ascertain what lands each *patnidar* holds in excess of those covered by his lease.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF THE BURDWAN ESTATE IN DIST. BANKURA.

No. 2 PARTY.



Reg. No. 582. S. I. D.—Nov. 93.—2,352.

Photo., S. I. O., Calcutta.

273. The traverse survey this season was confined to the traversing of sub- and village circuits, the whole of the main circuit traverses having been finished during the previous year. The whole of the scattered areas brought under traverse survey in district Bankura has now been divided into nine main circuits, within the limits of which sub-circuits have been surveyed. These main circuits have not in all cases, however, been surveyed along their entire lengths as main circuits in regular form. As it was necessary to incorporate the previous scattered cadastral surveys with the present 4-inch skeleton survey and form the entire area into one connected whole, the limits of the main circuits have in some places been formed from village boundary traverses, in some from sub-circuit and in others from old main circuit traverses.

274. The out-turn of traverse work for the season is—

District.	Number of villages.	Number of sub-circuits and sub-traverses.	Number of traverse stations.	Area in square miles.
Bankura	296	55	2,891	126

275. The whole of the traverse surveys in district Bankura made during the past five seasons have now been properly amalgamated, and connected with nine Great Trigonometrical Survey stations.

276. Owing to the causes mentioned in paragraph 376 of the General Report for 1891-92, the re-observation and re-measurements had to be continued into this field season. The work of re-survey extended to 163 villages, for which 1,821 angles were observed, and measurements made aggregating 258 linear miles. No separate cost has been calculated for these re-surveys, it having been debited to the 126 square miles of fresh area traversed this season.

277. Permanent marks were the same as used last year, *viz.* stone prisms for tri-junction of *mauzas* and clay cylinders for intermediate theodolite stations. The stone prisms used were the balance of last year's supply, it having been anticipated that the whole area would have been finished then.

The pottery marks were of two sorts: those made by local potters in the more populous portion of the work and those procured from Messrs. Burn and Company for the sparsely populated and jungly country on the Raniganj-Bankura road. The locally-made cylinders cost from R4 to R6 a hundred, and are of the nature of common roofing tiles. With great care the breakages during transit are at least 10 per cent., while the supply is dependent on the caprice as well as the working capacity of a number of potters. The Raniganj cylinders are similar to Messrs. Burn and Company's drainage pipes, are glazed and not easily broken, except by culpable carelessness in loading and unloading during transit. The cost of these pipes is R12-4 a hundred, but they can be had in large quantities by specified dates, and, apart from their being practically everlasting when once embedded, they will be more easily recognizable hereafter than the ordinary locally-made cylinders, which differ in no particular from the cultivators' usual pottery ware, of which fragments are to be found lying all over the country.

278. The field work was throughout the season supervised by Mr. A. B. Smart. From the commencement of the skeleton boundary survey, on the 4-inch scale, the *patnidars*, who were the parties most interested, were very active in their opposition, and as they are the people in possession, the pointing out of boundaries lay entirely in their hands. The *amins* were thus dependent for information on those who were most interested in withholding it, and the progress was in consequence very slow. Certain men called *nishandars* were placed in attendance on the *amins*; their employment was sanctioned by the Board, in their No. 1268A., dated 21st September 1893, to the Director, Land Records. These men were supposed to give the *amins* information regarding present leaseholders of the lands to be measured, to place the *amins* in touch with the villagers, and to render any assistance in their power in having boundaries pointed out. Their services were eventually also utilized in preparing the *khasras* in Bengali.

279. By the end of March it became apparent that without an increase of establishment the programme of boundary survey work would not be completed

during the year: an increase of *amins* was made in consequence. The Director of Surveys enquired into the cause of the small out-turn during March, and after a visit to Bankura, in company with the Director of Land Records, on 1st April, he came to the conclusion that the main causes of delay were opposition on the part of *patnidárs* and others, as well as the want of a revenue officer to assist the survey. A list of *patnidárs* who had failed during the previous season to render information under section 5, Act V, 1875, was sent to the Collector, and it was expected that action taken by that officer in compelling the submission of necessary returns would have had a good effect on the *patnidárs*. But what with notices to show cause, proof of service of notices, etc., time slipped by without any apparent change in the attitude of the *patnidárs*. The removal of theodolite marks also proved a great source of trouble to both the traverse surveyors and *amins*.

280. The following table shows the out-turn of skeleton boundary survey:—

District.	Number of villages.	Number of *chaks*.	Area in square miles.
Bankura	1,932	6,886	782·9

The measurement of the above necessitated 8,610 linear miles of chaining exclusive of offsets. The average areas are, per village 259 acres, and per *chak* 73 acres. *Chaks* as here applied mean separate areas having separate interests, and for each of which an entry has had to be made in the special register or *khasra*.

281. The skeleton survey was plotted on the scale of 4 inches = 1 mile. The *amins* were supplied with copies of the *thakbust* maps of 1854 as guides to the *mauzas* and interior blocks which should be separately mapped. These *thakbust* maps were plotted on scale 16 inches = 1 mile from compass and chain surveys, and are very good guides as to boundaries. They are accompanied by statements showing possession during survey in 1854, so that *amins* were acquainted with the extent of Raj lands in each *mauza*. Boundaries have, however, been surveyed according to present possession, which does not in all cases agree with that shown on the *thakbust* maps. Where differences occur on boundaries between two *patnis* belonging to the Burdwan Raj, there will be no immediate necessity to investigate the causes which have led to the disagreement. Along the outer boundaries of the Raj estates, only three boundary disputes were raised. Of these one was settled amicably, and the other two have been made over to the Collector to be decided by a revenue officer, as ordered by the Director of Land Records.

282. Owing to demands on the inspector's time for arrangement of attendance, etc., the amount of *partal* laid down in the instructions was not carried out. As the work was divided into blocks of villages on one sheet, the tests were applied to ensure that work in each block was accurately done. Mr. Smart, during his inspections, had boundary lines re-surveyed and checked on the spot. The areas of individual *mauzas* were checked by the summation of *chak* areas which were extracted by the acre comb in the cases of small blocks, against the universal theorem area—plus or minus offsets—as entered in the traverse tables.

283. The whole of the Burdwan Raj estates in district Bankura have now been surveyed and the work is being plotted on congregated village sheets on the 4-inch scale.

284. No records have been furnished to the civil authorities, as the nature of the survey does not demand it. The Manager of the Burdwan Raj, at whose request the survey has been undertaken, will, however, be supplied with traces of the maps, the original field *khasras*, and other information regarding the *patnis*, which will be furnished in lists. The whole of the *thakbust* maps, copied by the Survey Department, will also now be made over to the Manager for use in his office.

Jalpaiguri Mapping.

285. The section employed on completion of the Jalpaiguri 4-inch and 2-inch mapping was, at the commencement of the season, under Mr. W. H.

Penrose. It consisted of eleven draftsmen and typers, mostly temporary hands. On Mr. Penrose's transfer Mr. G. Campbell, on return from Pataspur, took over the work.

286. Forty-eight 2-inch scale forest sheets were completed and made over for reproduction. These had been prepared as ordinary standard form sheets measuring 3′ 45″ of latitude by 7½′ of longitude, and each or most of the sheets containing but a small portion of a forest block. The Conservator of Forests, Bengal, has since requested to have the maps supplied to him as complete forest block sheets without regard to uniformity of size of sheets, and the detached portions having been reproduced by photography are now being joined up as required in the Head-Quarters Drawing Office. The time and labour spent on preparation of the borders and footnotes of the original sheets have thus been entirely thrown away. On the handing over of these forest sheets on 1st April, the establishment of draftsmen was reduced to four, and subsequently to only two men.

Thirty-six sheets on the 2-inch scale, in all, representing nine 1-inch standard sheets, are approaching completion. Of these, however, but twenty-seven contain topography.

287. The tea lands in the district not having come under survey, large blank patches without any topography are to be found on almost every 2-inch sheet. As maps of these tracts done by local agency were known to be in the office of the Deputy Commissioner of Jalpaiguri, application was made for their loan, and about 100 sheets of individual tea grants were received and reduced from the 8-inch to the 2-inch scale. When the collected blocks fitted in to their proper relative positions were placed in the blanks on the Survey sheets, the exterior boundaries of the grants were found in most cases to agree fairly well with the boundaries of spaces left for them: the interior topography, however, seems utterly worthless. In many cases, streams, roads, etc., are shown in one block, but no traces of these are to be found in the adjoining blocks. Even the cultivation shown is not likely to bear much resemblance to the existing cultivated area. Possibly it might be worth while entering the boundaries of the individual grants. At present these great blanks deprive the isolated bits of accurate topography of much of their value, as it is often uncertain what roads, streams, etc., re-appear in the surveyed portions. The practice in the district of giving the names of the owner for the time of each hamlet to the hamlet itself has made the question of what names should be entered, one of difficulty, as the names must constantly change. At present the maps are very sparsely provided with names of localities. The question of names, as also of tea grant topography, has been referred to the Bengal Government. The date of completion of the sheets will largely depend on what additional work may be ordered.*

* Among the officers serving under Captain Fleming, Messrs. J McHatton and L. F. Berkeley are selected for special mention for their zeal and intelligence.

SHWEBO DISTRICT, UPPER BURMA.

No. 3 Party.

288. The programme for this party, as at first laid down, consisted of the continuation of traverse operations in the Shwebo district, the cadastral survey of as much of that district as could be completed in the season, and the commencement of traverse work in the Yeu district. A detachment was also to relay a section of the Burma-Manipur boundary, where a dispute in connection with a salt well near Kongal thana had arisen. During the field season arrangements were made, with the sanction of the Burma Government, for the topographical survey on the scale of 2 inches = 1 mile of 160 square miles of rough country near the Irrawaddy river, for the Shwebo Coal Company, as well as for the survey and demarcation of certain blocks in the Katha district, in which gold mining rights were to be granted.

Personnel.

Mr. G. B. Scott, Deputy Superintendent, 2nd grade, in charge.
„ A. E. Spring, Assistant Superintendent, 1st grade.
„ J. Connor, Extra Assistant Superintendent, 3rd grade,
„ O. D. Smart, Sub-Assistant Superintendent, 1st grade.
„ P. J. Serrao, Sub-Assistant Superintendent, 1st grade.
„ F. P. Walsh, Sub-Assistant Superintendent, 2nd grade.
„ W. J. Baker, Sub-Assistant Superintendent, 2nd grade.
„ H. B. Powell, Sub-Assistant Superintendent, 3rd grade.
„ O. C. Ollenbach, Sub-Assistant Superintendent, 3rd grade.
„ W. Newland, Sub-Assistant Superintendent, 3rd grade.
30 sub-surveyors and others.

Temporary Establishment,

10 inspectors.
100 field surveyors (Indian).
20 ditto (Burman).

289. Traverse and cadastral work was commenced during the first week in December and field operations were closed early in June, except of those sections employed on special work, which were continued till the end of June.

290. The demarcation in the Shwebo district was still in progress when the party took the field and was not sufficiently advanced to allow of the whole traverse section being employed on that district. Some progress had, however, been made in Yeu, so the traverse surveyors who could not be employed in Shwebo were ordered to commence work in Yeu. Much delay had been caused by the sub-division of villages or *yuas*, i.e. lands under one *thugyi*, into *kwins* or sub-divisions. No such boundaries previously existed, and where no hamlets lay within these blocks, names had to be invented for them. After consulting the Deputy Commissioners, a proposal was made by the Deputy Superintendent, and agreed to by the Director of Land Records, that only recognised existing boundaries should be demarcated before survey, and that any sub-divisions required should be made hereafter by the settlement or supplementary survey officers, with the aid of the 16-inch plans. This greatly assisted the progress of the work; in Yeu all villages lying in open country were demarcated, and in Shwebo enough was done to allow of the cadastral survey of all open country being completed.

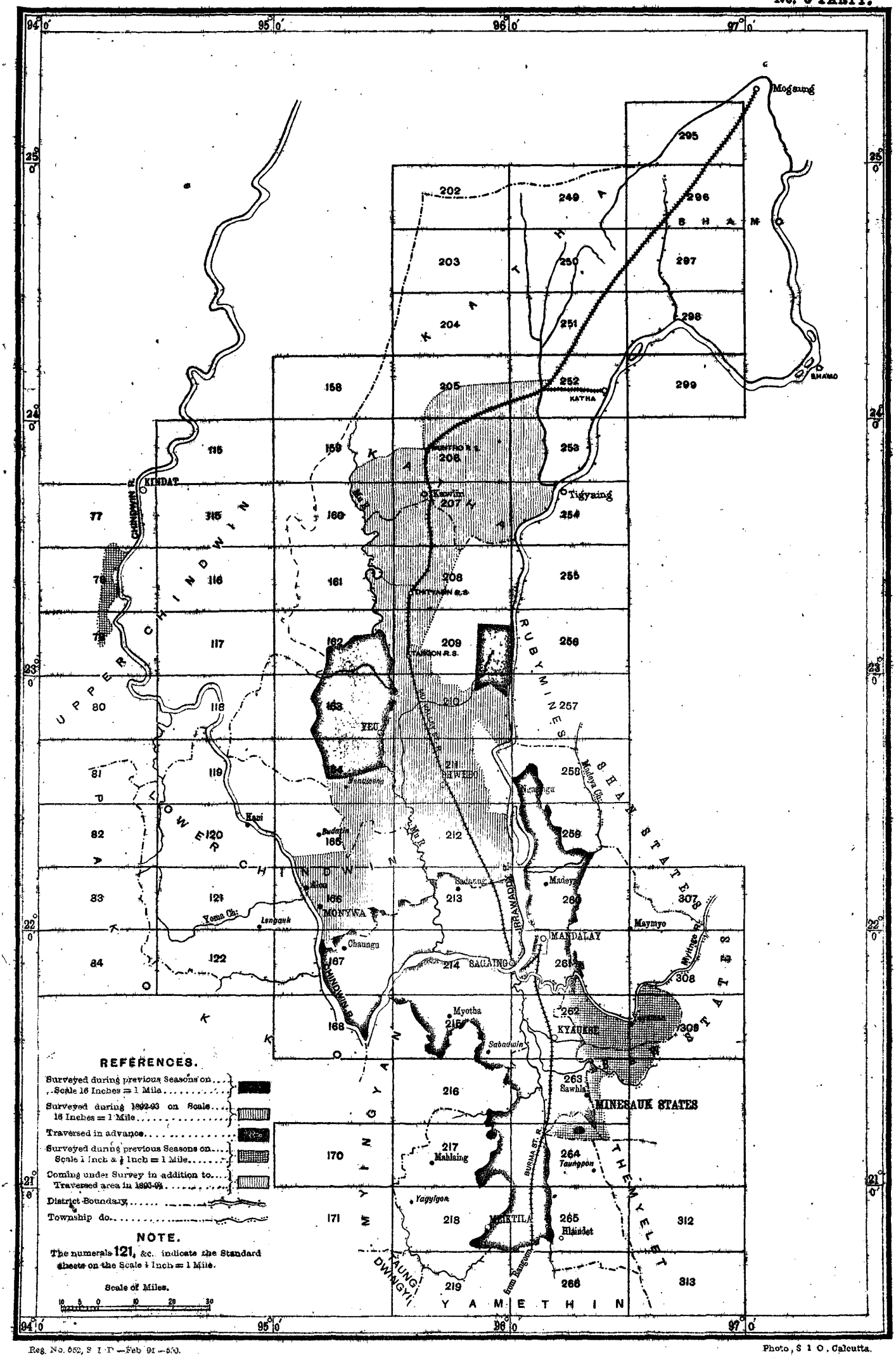
291. According to the Burma Boundaries Act, where village boundaries run through jungle, lines 9 feet in breadth should be cleared from pillar to pillar. This was not done by the demarcation officers; consequently, the whole labour and expense of clearing lines fell on the Survey party, and this was considerable, especially as in the northern and eastern portions of the district the boundaries run through heavy tree, or worse still, bamboo forest.

292. About 800 square miles had been traversed in the Shwebo district in 1891-92; 870 square miles more were traversed therein during this season and 942 square miles in Yeu. A block of 70 square miles near Shwebo town, which had been previously traversed and surveyed by local agency, was incorporated with the work, the angles being re-observed and the lines re-measured: astronomical azimuths were also observed, and the bearings, which had been based on magnetic readings only, were corrected accordingly. The total area of the Shwebo district is about 3,000 square miles; consequently, 1,300 square miles remain untraversed, but the bulk of this area is a mass of intricate hills, ravines and forest, unsuited for cadastral operations. The few hamlets and small patches of cultivation in it could be more economically done by the local survey agency, whilst a topographical survey of the whole should be made hereafter. In the area traversed, however, there are considerable portions

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. SAGAING, SHWEBO, MANDALAY, MEIKTILA, & KYAUKSE.

No. 3 PARTY.



REFERENCES.

- Surveyed during previous Seasons on Scale 16 Inches = 1 Mile
- Surveyed during 1892-93 on Scale 16 Inches = 1 Mile
- Traversed in advance
- Surveyed during previous Seasons on Scale 1 Inch & ½ Inch = 1 Mile
- Coming under Survey in addition to Traversed area in 1893-94
- District Boundary
- Township do.

NOTE.

The numerals 121, &c. indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

Scale of Miles.

16 5 0 10 20 30

Reg. No. 652, S. I. T.—Feb '94—500.

Photo, S. I. O., Calcutta.

No. 237-S. 94.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT SHWEGYIN.

No. 7 PARTY.

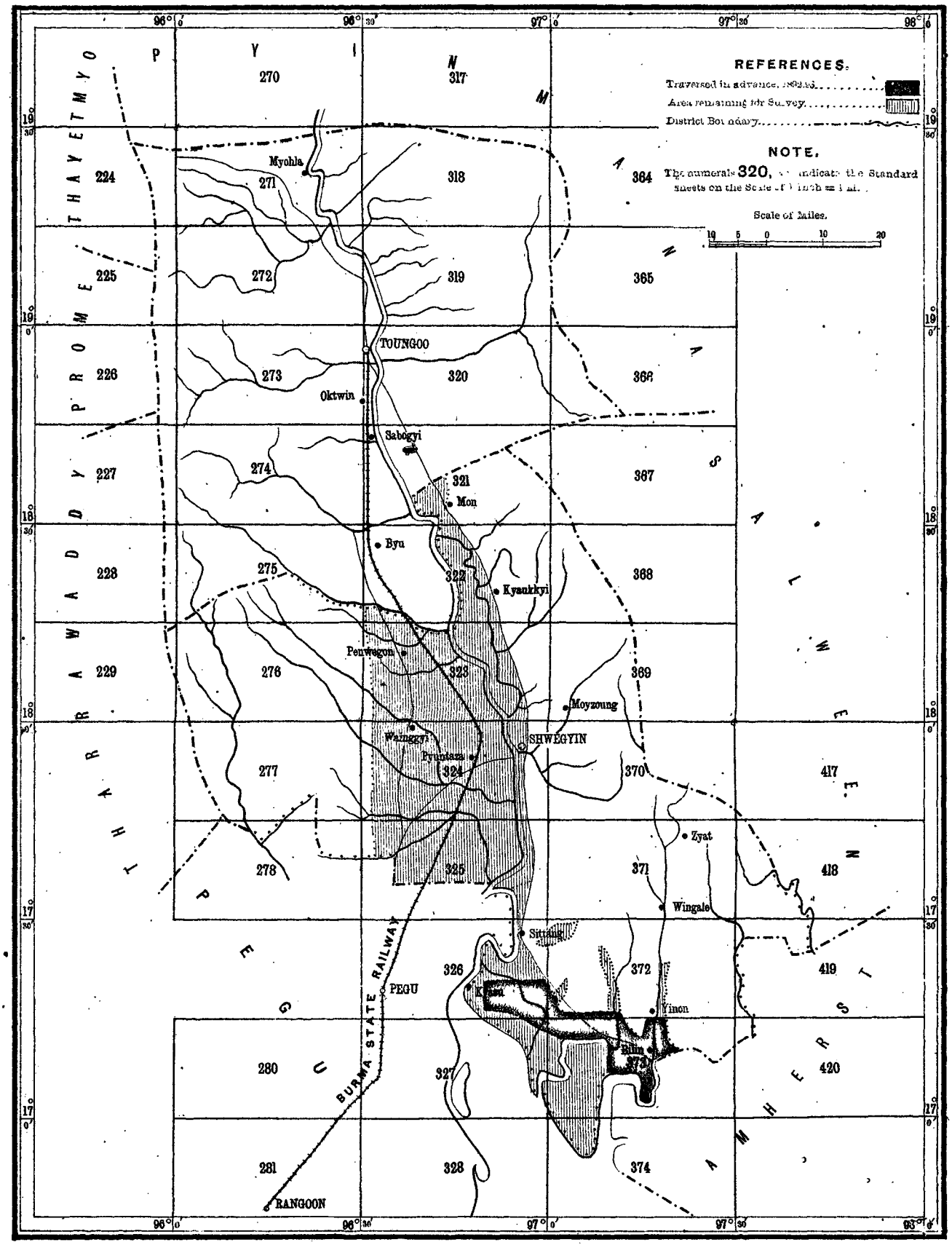


Photo., S. I. O., Calcutta.

No. 234-S. 94.

of country where the villages and cultivation occupy positions in heavy forest through which the boundaries run. In these cases the traverse work involved great labour and greatly increased expenditure.

293. In the district of Shwebo, 24,461 survey stations have been marked by cylinders of glazed pottery, of which 12,466 were fixed and embedded this season. In Yeu, 16,677 have been similarly marked. Two-inch plots of all surveyed villages, showing the position of these permanently-marked stations, have been distributed to all *thugyis*. In future it is intended to make rough plots on the 2-inch scale for the *thugyis* as soon as possible after the traverses have been completed, to prevent their pleading ignorance of the position of the permanently-marked stations, as an excuse for not seeing to their preservation.

294. In Shwebo 1,731 linear miles of chaining were run, and in Yeu 3,206 miles; two sets of chains were used throughout. The angular work was checked by 56 azimuths in Shwebo, and 80 in Yeu, and the average correction was one minute in 12 angles. A principal series of the Great Trigonometrical Survey has been carried up the Irrawaddy: the stations of Sheinmaga, Male and Zintaung of that series lie on the eastern side of the Shwebo district, among hills and ravines, and a fourth station, Mingun, lies very close to the southern boundary. These points furnished a check to the chaining from north to south, but there are no G. T. S. stations to the west, and the positions of the stations of the topographical survey are not sufficiently accurately fixed to allow of a proper comparison being made. To remedy this, two prominent topographical stations about 10 miles west of the G. T. series were connected by careful triangulation with three G. T. S. stations, and the traverse work was compared with these two stations. The comparison from Mingun G. T. S. in the south to Kongyi H. S. to the north, gives a difference of about 3 feet per mile. The positions of 40 masonry pagodas were fixed by theodolite observations this year in Shwebo, making a total of 143 in that district; in Yeu 93 pagodas have been thus fixed.

295. The theodolite was, as before, fixed on the magnetic meridian at each traverse station. On searching for causes for the wide discrepancies in magnetic readings, it was found that several surveyors used the ordinary hurricane lantern for reading the instrument when observing at night; being largely made of tinned iron; this, when placed near the needle, affected its position, and incorrect readings were recorded. Several needles gave irregular results, owing to the bluntness of the point on which they swung. No other causes could, however, be discovered for the various readings at many of the stations, which would appear therefore to be really due to variations of the magnetic meridian. On rejecting the observations at azimuth stations, which have been proved to be erroneous for the above reasons, and again deducing results from numerous readings furnished by the traverse survey, the average variation for Kyaukse was found to be 2° 24′ and for Mandalay 2° 26′ east. As the topographical survey has given 2° 25′ east as the mean variation for the quarter-inch sheets, this figure has been adopted as the mean variation for the 2-inch sheets of those districts. For Sagaing the mean variation was found to be 2° 20′ east, and for Shwebo 2° 21′ east.

296. Cadastral survey operations were commenced in the first week of December. It having been proved, from the rapid progress made last season, that a small establishment of field surveyors would suffice to complete the proposed programme, no steps were taken to replace the 7 squads which had been sent to assist No. 12 Party last year. Traverse plots of 800 square miles being available at the commencement of the season, rapid progress was made in the detail work; so much so that the traverse section in Shwebo, which was working through heavy jungle, could not keep up a sufficient supply of plots; consequently 3 squads of *amins* were employed in Yeu to prevent their remaining idle.

297. For the past two seasons the experiment has been made of paying Inspectors in proportion to the amount of work turned out by the *amins* they bring, *i.e.* each Inspector has been paid monthly according to the average earnings of his men: consequently he benefits by their working fast and well, and loses by every delay caused by rejected work. The system has worked very well. Each Inspector picked his own squad in India, and sent the list for approval, at least one month before departure from his home.

298. At the request of the Manager of the Shwebo Coal Company, and with the sanction of the Burma Government, it was arranged to make a 2-inch topographical survey for prospecting purposes of 160 square miles of hilly country near the Irrawaddy, while all cultivated lands lying within the tract were to be surveyed cadastrally. The bulk of the drainage was traversed, and a triangulated ray trace run from Malé G. T. S. to Kabwet; but at first hazy weather, then an exceptionally early and heavy rainfall, prevented the completion of the work. This will be continued during the coming season.

299. In April the Deputy Superintendent was ordered to arrange for the survey of certain blocks of land north of Wuntho, in the Katha district, grants for which had been applied for, for gold-mining purposes. These blocks were scattered among forest-clad hills at considerable distances from one another. Thirteen square blocks, each of a quarter square mile in area, for gold-mining concessions, and two of one square mile each for prospecting leases, were demarcated and surveyed on the scale of 8 inches = 1 mile, and their positions fixed by connections with the nearest topographical stations. The portion of the country where these blocks lie is notoriously unhealthy during wet weather, and all the men employed suffered severely in consequence of the early rain, which fell and caught them before they could complete the work and get out of the unhealthy districts.

300. The total out-turn of work for the season is given in the following table:—

Districts.	Traverse.		Cadastral Survey, 16 inches = 1 mile.			Topo. Survey, 8-inch scale.
	No. of villages.	Area in square miles.	No. of villages.	No. of fields.	Area in square miles.	Area in square miles.
Shwebo	213	870	242	762,170	1,559	...
Yeu	641	942	231	132,614	207	...
Katha	...	...	...	...	...	6
Total	854	1,812	473	894,784	1,766	6

301. The proportion of the cultivated area is probably about 50 per cent. of the total area surveyed. The average size of the field, calculated on the whole area surveyed, is 1·21 acres, but, reckoned on the cultivation only, it would be about half an acre.

302. As usual, every sheet was checked both during progress of survey and after the sheets had been received in office; 1,191 linear miles of check survey were run by European Officers on board plans or in field books, and 1,373 miles by inspectors.

303. A question having arisen as to the exact boundary between Manipur and the Shan State of Thaungdut in the neighbourhood of Kongal thana, the Burma Government requested that a Survey officer should be deputed to locate the boundary as laid down in 1882. Mr. Serrao, a Sub-Assistant Superintendent from No. 3 Party, was selected for the purpose. The primary cause of the dispute was the possession of a salt spring which the Thaungdut Sawbwa claimed. The Deputy Commissioner of Kindat, accompanied by Mr. Serrao, arrived at Kongal thana on the 11th December and were met there by a *subadar* from Manipur, who had been deputed by the Political Officer of that State to point out the boundary as demarcated by the Boundary Commission in 1881-82 under Lieutenant-Colonel Johnstone; the *subadar* pointed out five cairns of stones which had been erected in 1882, but beyond this he appeared to know nothing of the boundary. The positions of these cairns agreed very closely, in some cases exactly, with the boundary as shown in sheet No. 96 of the North-East Frontier Topographical Survey by Major Badgley, in 1881-82, which had only been surveyed topographically with a plane-table; they were accepted as correct, and their positions were accurately fixed by triangulation, and a traverse survey

was made of the line of boundary under dispute. The traverse stations, 56 in number, were all marked by embedding stones on which were cut a circle and dot. Ten new cairns have also been erected, so as to better define the boundary which may now be considered to run in straight lines between the cairns. According to this boundary, Kongal thana lies in Manipur territory, but as it is possible that on further investigation it may be considered advisable to alter the boundary so as to include Kongal thana and the salt spring in Thaungdut, two posts have been erected in positions which would be suitable for cairns defining such a boundary. These have been connected with the traverse so that the alteration might hereafter be made in the boundary without the assistance of a surveyor. On the 23rd December the boundary was pointed out to the Deputy Commissioner and the Manipur and Thaungdut officials, and the two posts were erected in the presence of the Deputy Commissioner.

304. The total cost for the survey year 1892-93 is ₹2,44,991; deducting from this the cost of the detachment sent to the Manipur boundary, ₹1,742, and the cost of the survey of gold-field blocks in Katha, ₹3,263; the cost of traverse survey is found to be ₹42-7-7 per square mile, and that of cadastral operations, including mapping, tracing, and area estimating, etc., ₹88-0-10 per square mile, or 2 annas and 2 pies per acre.

305. By far the larger portion of the area surveyed cadastrally in Shwebo is dry upland, usually very much in need of water. About 70 square miles near Shwebo town are irrigated by the Mu canal, which is, however, at present in a sadly neglected state; portions of country near the Mu river also produce rice. When the irrigation projects now in progress are completed, fully 1,000 square miles of country will probably be supplied with water. Owing to a scanty or untimely rainfall, water was very scarce in parts of Shwebo last season, and crops failed, causing some distress. Hundreds of families eked out an existence by collecting salt from surface washings.

306. It was found possible to utilize more local labour this year than hitherto. Only 500 *khalásis*, etc., were this year brought from India, in place of 920 in 1889, which represents a saving in passage money alone of ₹12,000 in the year. Over ₹11,000 were paid to villagers, which would otherwise have been paid to Indians. The villagers are more willing to accept 4 annas a day for survey work, which is in and around their villages, when they can return to their homes every evening for meals, than they are to take 8 annas a day for heavy earthwork and other continuous labour away from home, when they have to purchase supplies; hitherto, therefore, no difficulty has been experienced in getting men, or rather old men and boys, who are fitted for the purpose. But as all other departments are paying 8 annas a day, and the district officials in Shwebo consider it necessary to pay men employed on clearing boundaries at this rate, it is feared that those working with surveyors will also soon begin to demand the higher rates, when it will be cheaper to again import all *khalásis* from India, as these come willingly for ₹10 per mensem.

307. It is to be regretted that of the 20 Burman field surveyors and the other men, draftsmen, etc., who were employed in the party, few are men of the districts under survey. If there were any object in employing men from Lower Burma, there is little doubt that as many men as are to be found in the other two parties could be obtained, but as long as the out-turn of work by Burman surveyors is more expensive, there is no advantage to be gained by employing Lower Burmans in Upper Burma in preference to Indian *amins*, as the main object of employing Burmans, *viz.* of leaving a certain number of trained surveyors in each district, would not be furthered by so doing. A proposal has now been made to the Director of Land Records that a certain number of students from the schools at Shwebo, Yeu, etc., or other young men, relatives of *thugyis* employed in the districts under survey, should be attached to the Survey party for one month to learn surveying; that they should be allowed ₹10 for this period, and sent with Indian *amins* to be trained; and at the end of the month that those who cared to undertake it should be given employment on contract rates. Of the Burman surveyors previously employed in this party, several were last year sent to No. 12 Party, and being mostly men from Lower Burma, they have preferred remaining with that party, as its field of operations is nearer their own homes, while others from Kyaukse, Mandalay, and Sagaing have found employment in the local supplementary surveys at work in those districts.

308. Tracings and area statements of the entire Sagaing district were made over to the Settlement Officer in that district. A second set of tracings has been called for by the supplementary survey, and are being prepared almost exclusively by Burmans. The 16-inch sheets of Shwebo and Yeu, 2,044 in number, have been inked up and traced, and the areas of the greater number of surveyed villages have been extracted and are ready for submission to the Settlement Department. The 2-inch sheets of Sagaing have been prepared, but are detained pending completion of settlement operations.

309. The Irrigation Department has applied for 4-inch maps of Shwebo and parts of Sagaing, the 2-inch scale not being sufficiently large for their purposes. These are now being prepared; when completed, they can be reduced by photography to the 2-inch scale and redrawn for further reduction to ·1 inch for publication in the standard form. The Irrigation Department is prepared to pay the entire extra cost entailed thereby.

310. A description of the country surveyed in the Shwebo district will be found in the appendix.

311. The health of the establishment in Shwebo and Yeu was excellent; only two men died. The detachment in Katha and in the Shwebo coal tract suffered severely from fever, but there were no deaths. The relations with civil authorities were cordial throughout the season, and as usual the Survey employés and villagers were on the best of terms; only one assault case was brought before the Court, and in that both parties were Burmans.

312. The programme for next year is a varied one. It includes the completion of the cadastral survey of the cultivated portions of Shwebo and the topographical survey of 160 square miles in the same district for the Shwebo Coal Company; also the cadastral survey of the portion of Yeu that has been traversed. In the Katha district, an area of about 300 square miles is to be traversed and surveyed cadastrally, and traversing is to be carried on in advance if necessary, and the demarcation and survey of grants of land in the gold-fields north of Wuntho. The traverse and cadastral survey of portions of the districts of Yamethin and Meiktila will also be undertaken. A squad of native surveyors has also to take up the cadastral survey of certain lands in the Upper Chindwin district, where considered advisable by the Deputy Commissioner, owing to the existence of tenure questions that require early settlement. Lastly, a traverse detachment will refix the exact positions of so many of the theodolite stations in the Kyaukse district as have been destroyed or lost, as may be required for future surveys, or will replace them by a re-traverse of boundaries where necessary.

313. Mr. Spring superintended traverse operations in Shwebo, and to ensure his becoming conversant with all the details, he conducted the traverse work and cadastral survey of a small section of country. He has been attentive to his duties both in field and office.

314. The Deputy Surveyor-General twice examined the party during the past season, once in the field and once in recess, and expressed a very favourable opinion regarding the working of the party.*

BIHAR.

NOS. 4 & 5 PARTIES.

315. The survey of Northern Bihar was commenced last year under the sanction of the Government of India conveyed in their letter No. $\frac{2135}{412}$, dated 15th September 1891, to the Bengal Government, and the four districts, Muzaffarpur, Darbhanga, Champaran and Saran, were notified under the Survey Act on the 17th November 1891. The operations were confined in that year to prelimi-

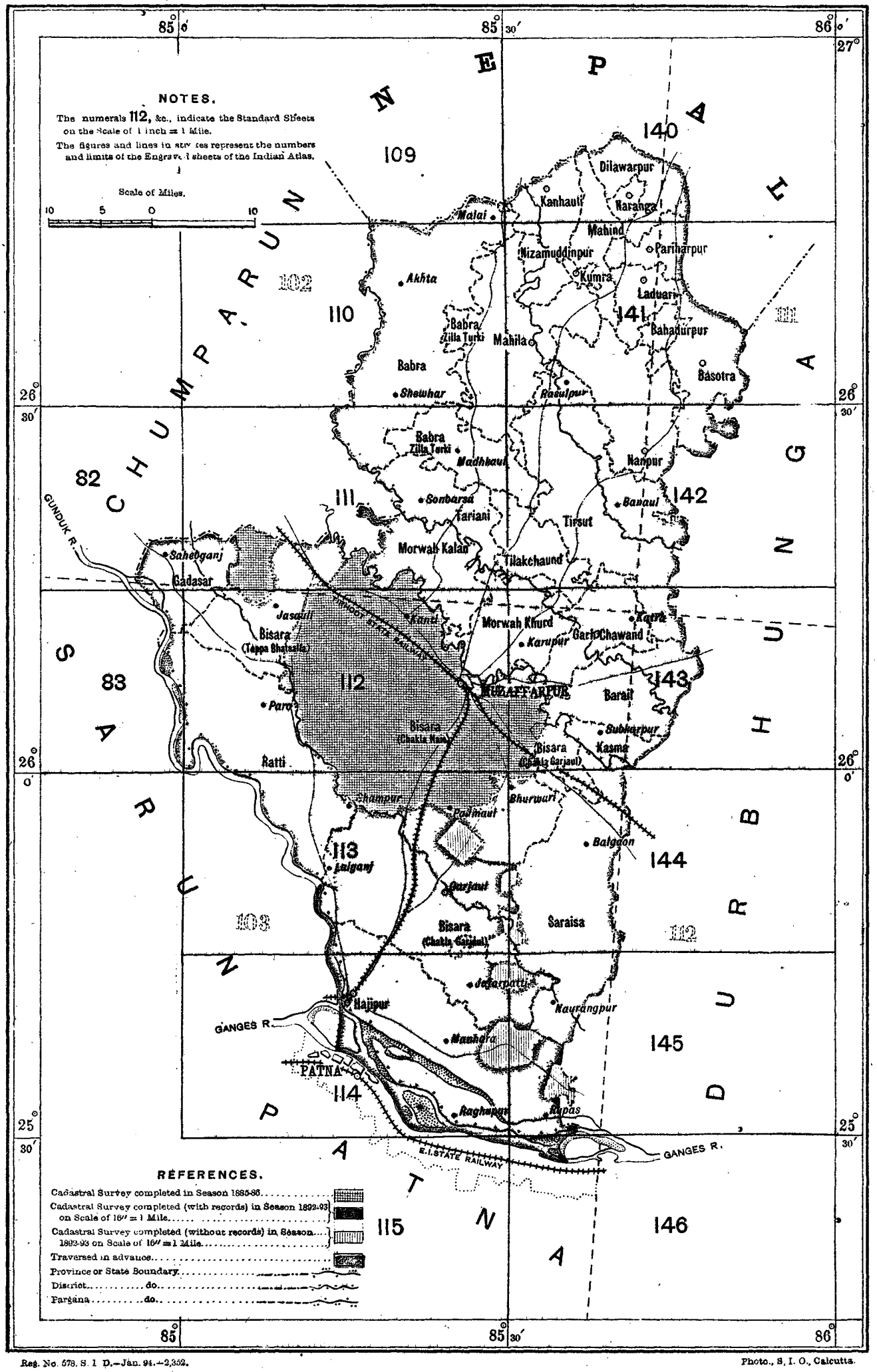
* Mr. Scott in his report speaks well of all his assistants. Mr. J. Connor superintended the cadastral operations generally, and Mr. O. D. Smart superintended the traverse work in Yeu, and both performed their duties satisfactorily. Messrs. Serrao, Walsh, Baker, and Powell all did good work. Mr. Ollenbach, a new hand in the field, promises to be quick and a neat topographical surveyor.

He also mentions favourably his English writer, Bhagobutty Charan Chuckerbutty, Pandit Kedarnath, Bhola Nath, Rohan Lall, Gafur Bux, Lahauri, Mohamed Shafi, Abdul Hasan, Rafartulla, and Surfaraz Khan.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. MUZAFFARPUR.

Nos. 4 & 5 PARTY.



Reg. No. 573. S. 1 D.—Jan. 94.—2,352.

Photo., S. I. O., Calcutta.

No. 210-S. 94.

nary traverse work in the Muzaffarpur and Champaran districts, in which an area of 1,610 square miles was prepared by a detachment, the account of which was given in last year's report at page 71.

316. This detachment was strengthened at the commencement of the field season under report by the addition of No. 4 Party, which had completed its operations in the Western Duars, and also by the transfer of a traverse section from Orissa. The establishment was thus brought up to the strength of nearly two ordinary parties and it has been designated Nos. 4 and 5 Parties. These parties were sub-divided into four sections, two of which were employed on traverse work and two on cadastral survey in the Muzaffarpur and Champaran districts respectively. On the conclusion of the traverse survey in these districts, both traverse sections were transferred to the Saran district to commence operations there. The charge of the parties was held by Captain G. B. Hodgson, S.C., except during his absence on privilege leave for two months, when Mr. J. S. Pemberton held charge.

317. Before proceeding to describe the operations in detail, it may be well to state the general principles which governed the procedure during the season under report, as considerable changes have since been introduced. They were briefly as follows:—

The amalgamation of the two departments of Survey and Settlement, as parts of one establishment working jointly to a common end, was insisted on as the radical principle on which all concerned should act. Thus each cadastral camp became *de facto* the settlement office, and the Survey inspectors and *amins* or *patwaris* became the Settlement Officers' establishments for all the purposes for which separate establishments had previously to be employed in the field. The Extra Assistant Superintendents and Sub-Assistant Superintendents supervised the construction of the maps, and, acting under the orders of the Settlement Officer, the writing of records, which proved a tangible accession of strength to the Settlement Officer, under whose responsibility the record-writing was done. The Deputy Superintendent acted jointly with the Settlement Officer and supervised all the professional work.

Such a system made it possible to have one process in the field and in office instead of several, and one establishment for the execution and supervision of the maps and records in place of two. In the one operation all that is necessary for the completion of the record was done, and the final attestation is the only after stage. This is now proceeding at the Settlement and Assistant Settlement Officers' camps.

There is a radical difference between this procedure and that formerly prevailing, when the survey officials were held responsible for the accuracy of the record-writing which was not completed in every particular, but only certain columns were filled in at the *khanapuri* stage.

Survey of the Muzaffarpur District.

318. The programme of traverse survey for the Muzaffarpur district was the completion of the district, in which an area of about 1,000 square miles remained in the Sitamarhi and Muzaffarpur sub-divisions.

Personnel.

Captain G. B. Hodgson, S.C., Officiating Deputy Superintendent, 1st grade, in charge to 3rd July and from 5th September 1893.

Mr. J. S. Pemberton, Assistant Superintendent, officiating 1st grade, in charge from 3rd July to 4th September 1893.

No. 1, Traverse Section.

Mr. J. S. Pemberton, Assistant Superintendent, in charge to 3rd July and from 5th to 30th September.

Lieutenant A. J. Pilcher, R.E., Assistant Superintendent, 2nd grade.

Lieutenant C. W. H. Symonds, S.C., Assistant Superintendent, 2nd grade, on probation, from 5th November 1892.

Mr. L. F. Berkeley, Sub-Assistant Superintendent, 1st grade, to January 1893.

Mr. P. K. Vaughan, Sub-Assistant Superintendent, 3rd grade.

27 sub-surveyors.

14 computers.

319. The unit of traverse surveys is the *mauza* as demarcated by the *zamindárs*, but comparison with the maps of the old Revenue Survey was made by means of rough 4-inch scale plots of the traverse work, on which all differences of any importance have been noted. As a rule, however, the boundaries were found to agree well.

320. In cases of disputed boundaries at the commencement of the field season, the traverse line was taken between the two boundaries pointed out, so long as the offset limit of three chains was not exceeded. If it were so, both boundaries were traversed, the usual marks being laid down at the theodolite stations. In January, however, it was represented by the Secretary to the Indigo Planters' Association that the carrying of the traverse line between the two disputed boundaries was always misunderstood by the villagers, who thought that the *amin* had thus taken upon himself to decide the disputes, and orders were then issued that in every case of dispute traverse lines were to be taken

along both boundaries, and no permanent marks put down at the theodolite stations, wooden pegs only being used, except when a trijunction was disputed, when the usual mark used for stations on tri-junctions was to be embedded at both points demarcated. When the dispute is disposed of by the Settlement Officer, one of the marks will be removed.

321. The demarcation of the village boundaries was done entirely by *zamindárs*, on whom notices in Form C of the Board's Survey Manual of 1892 were served well in advance of the survey.

322. The area traversed during the season is 997 square miles, and includes the *parganas* of Morwa Kalan, Morwa Khurd, Garh Chawand, and a portion of Tirsut, comprising the northern half of the Muzaffarpur sub-division and the whole of the Sitamarhi sub-division with the exception of Tirsut. The Ganges *diara* lands in *pargana* Hajipur were also traversed and the plots given out for cadastral survey, which was carried out this season also. In connection with this *diara* survey an area of 62 square miles was traversed of the Patna district, comprising one line of villages on the bank of the Ganges.

323. The out-turn of traverse survey is shown in the following statement :—

District.	Traverse Survey.			
	Number of villages.	Number of sub traverses.	Number of traverse stations.	Area in square miles.
Muzaffarpur	1,246	559	12,491	997

324. The traverses were connected with 11 stations of the Great Trigonometrical Survey, and the chain measurements checked thereby: the comparison between the trigonometrical and traverse distances gives an error of 6·23 feet per mile. The angular work was checked by observations for azimuth at 77 stations.

325. During the first two months of the field season, the theodolite stations were marked in the same way as was done during the previous season. All stations on village tri-junctions and one adjoining station were marked with the prism-shaped stones described in paragraph 414 of last year's report, and all other stations with burnt clay cylinders. Orders were then received that only village tri-junctions and not the adjoining stations were to be marked with stones. The number of stones used in the Muzaffarpur district during the season is 3,996, or 4 per square mile, and the number of tri-junctions is 2,030.

326. The same difficulty was experienced as before in getting the people to understand that the traverse lines cannot be taken exactly along the boundaries, and that if they cut through the village lands, they do not in any way prejudice their rights. Mr. Pemberton reports that on the whole there was considerably less obstruction offered to the traverse surveyors than was met with last season. This was noticeably the case in the Hatwa estate, where assistance was everywhere readily rendered.

327. Next season this party will traverse 1,000 square miles in the Saran district, about 300 square miles to complete the Tikari estate in Gaya, and 500 square miles in Darbhanga.

328. The cadastral section as detailed in the margin moved into the field on the 1st November 1892 under Mr. H. T. Hanby. Rules for survey and *khanapuri* were drawn up by Captain Hodgson and Mr. P. C. Lyon, the Settlement Officer of Muzaffarpur, and printed after approval of the Directors of Land Records and Surveys. They were based on the "Manual for Survey Parties in Bengal," compiled by Colonel Barron, of the Survey Department, in 1885, and on the Survey and Settlement Manuals of Bengal, 1892; they were then modified in accordance with orders that had been issued from time to time by the Director of Surveys. Several important changes were introduced.

Personnel.

No. 1, Cadastral Section.

Mr. H. T. Hanby, Extra Assistant Superintendent, 2nd grade.
Mr. G. T. Hall, Extra Assistant Superintendent, 4th grade.
Mr. H. H. B. Hanby, Sub-Assistant Superintendent, 3rd grade, from 1st February 1893.
2 sub-surveyors.
1 draftsman.

Temporary Establishment.

2 head inspectors.
25 inspectors and *partallers*.
241 field surveyors and *mukarrirs*.
59 office *muharrirs*.
15 estimators.
17 draftsmen and tracers.

329 By the middle of May 1893 the cadastral survey had been completed o 529 square miles, comprising the whole of the *parganas* Hajipur, Azimabad, Ghyaspur, and Bhimpur, including the Ganges and Gandak *diara* lands on the Patna and Saran sides respectively, up to the high banks, and also of 535 villages of Bisara, Chakla Garjaul.

330. The out-turn of cadastral survey is given in the following table:—

District.	Cadastral Survey. 16 inches = 1 mile.			Khanapuri.		
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Approximate area in square miles.
Muzaffarpur	1,153	731,277	529	1,052	641,277	466

The 16-inch scale was found to be large enough for all the village sites surveyed this season, with the exception of the bazar of Hajipur, where the scale was increased to 64 inches in places, consequent on fresh orders received regarding the survey and record-writing of village sites.

331. The detail survey was mapped on 1,111 sheets, and was tested by 565 linear miles of check survey by Europeans, 507 linear miles of independent check carried out after the maps were lodged in office, and 1,000 linear miles by inspectors. The average amount of test is thus very nearly four linear miles to each square mile of survey.

332. The average size of field calculated on the entire area is 0·47 of an acre, and excluding the *diara* which has an area of 133 square miles, 0·35 of an acre.

333. The cadastral survey in this district was mainly carried out by the agency of professional *amins*, although 359 men sent in by *zamindárs* were put through a course of instruction during the previous recess season for carrying out the survey. Of these, 154 only came forward for employment during the field season, and 32 were employed on survey and *khanapuri*, 39 on *khanapuri* alone and 82 as *khatian muharrirs*. Mr. Hanby, under whom the training was carried out, reports that the majority of these men were not *patwáris*, nor even relations of *patwáris*.

334. In the Hajipur *pargana*, a large number of *zamindárs* supplied the necessary labour, *viz.*, three coolies per diem while survey was in progress, and one during *khanapuri*; but in Chakla Garjaul, with the exception of a few villages, all labour was paid for by the Survey Department. The total area in which cooly labour was supplied by *zamindárs* is 224,670 acres or 351 square miles, while the survey of 10,231 acres and the *khanapuri* of 9,542 acres was done by *zamindárs'* employés.

335. The number of boundary disputes sent up to the Settlement Officer was 309. The majority of them have been disposed of, and the maps and records have been completed in accordance with the decisions arrived at. The maps and records of the villages, of which the disputes are not decided on the commencement of field work, will be handed over to the Settlement Officer, who has undertaken to complete them.

336. Of the 1,153 villages surveyed, the record of rights has been written of only 1,052 villages, representing an area of about 466 square miles. The survey was completed by the end of May, but *khanapuri* was continued under considerable difficulty till well into July, in order to complete the *khanapuri* of the Ganges *diara* during the season of survey. As the *khanapuri* of the *diara* was in progress up to the very end of the field season, the records could not be prepared in time to enable final attestation to be carried out during that season. The area was too large for all the operations of traverse survey, *khanapuri* and attestation to be carried out in one season.

337. The number of *khasra* entries checked by the European officers of the Survey Department is 8,202, and by native inspectors 115,326,—altogether 19 per cent. of the total number of entries. A large number were also checked by the officers of the Settlement Department and the Superintendent of Survey.

338. Of the out-turn given above, five square miles consist of 10 villages of the Darbhanga Raj situated in the Sitamarhi sub-division, quite apart from the rest of the cadastral work. The survey of these villages was carried out for the purpose of comparison with the maps of a survey done in 1880, under the orders of Mr. Finucane. Special arrangements had to be made for the supervision of this work; and to enable a comparison to be made, the old maps, which were on the *bigha* scale of about 65 yards to the inch, had to be reduced by pentagraph to the scale of the present survey. Captain Hodgson writes:—"The comparison is extremely difficult, mainly owing to changes in the field boundaries, and though fairly accurate, the old maps appear to be completely out of date. The sub-division of holdings is remarkable."

339. The cost-rates per square mile for the different classes of work are as follows:—Traverse, including cost of demarcation and stone embedding, ₹38·6; cadastral survey, including completion of maps, ₹78·7; record-writing, ₹73·4; and for training establishments, ₹2·3. Excluding the traverse survey, the cost-rate for the cadastral operations aggregates ₹154·4 per square mile. There are many causes for the rate being so high: (1) It was the first season of operations and all the extraordinary expenditure incurred in moving the party from another locality has been included. (2) The *amin* establishment being inexperienced, for the party had done no cadastral work during the previous season, and difficulty was experienced in getting together a good establishment; the inspectors and *amins* who were formerly employed with the party could not be obtained and a great many of those who were entertained proved very inferior surveyors, and a considerable amount of bad work was done which was rejected and redone. (3) The want of statistical forms, which caused a great deal of delay at the commencement of the rains.

340. On the 6th June, the field office establishment was transferred to the recess office at Muzaffarpur, and during the recess the following papers were prepared and added to the records which had been compiled in the field:—the *safawar* and *milan khasras* and crop statement of *jinswar*, while in the case of attested villages only, *terijes* of the *khatians* were also prepared. The preparation of these statistical papers will not be completed till well into November, when the work will be carried on by a special establishment at Muzaffarpur. This delay is partly due to the want of forms at the commencement of the recess season: they were not received till the middle of July. Till they were received the *milan khasras* and crop statements were prepared on manuscript forms.

341. On the return of the camp to recess quarters, a training school was formed for instructing the *patwâris* of the area to be taken up next field season, and the Collector was requested to arrange for the attendance of 200 men. Up to the third week of July, only 11 men appeared in answer to the summons. On the 7th August, however, orders were received that *patwáris* would not be employed during the coming season, but that the work would be carried out by 200 professional *amins*, assisted by 200 men belonging exclusively to Bihar, and who were to be thoroughly trained in survey and *khanapuri* before the end of October, when field work will again be commenced. By the end of August the full number had been enrolled, but the attendance of a great many was found to be so unsatisfactory that they were dismissed and others taken on in their places. This difficulty continued throughout the remainder of the recess, and it is doubtful if the full number of local men will be fully trained when field work commences. Only a small number of the men who were trained during the previous recess season have presented themselves for employment.

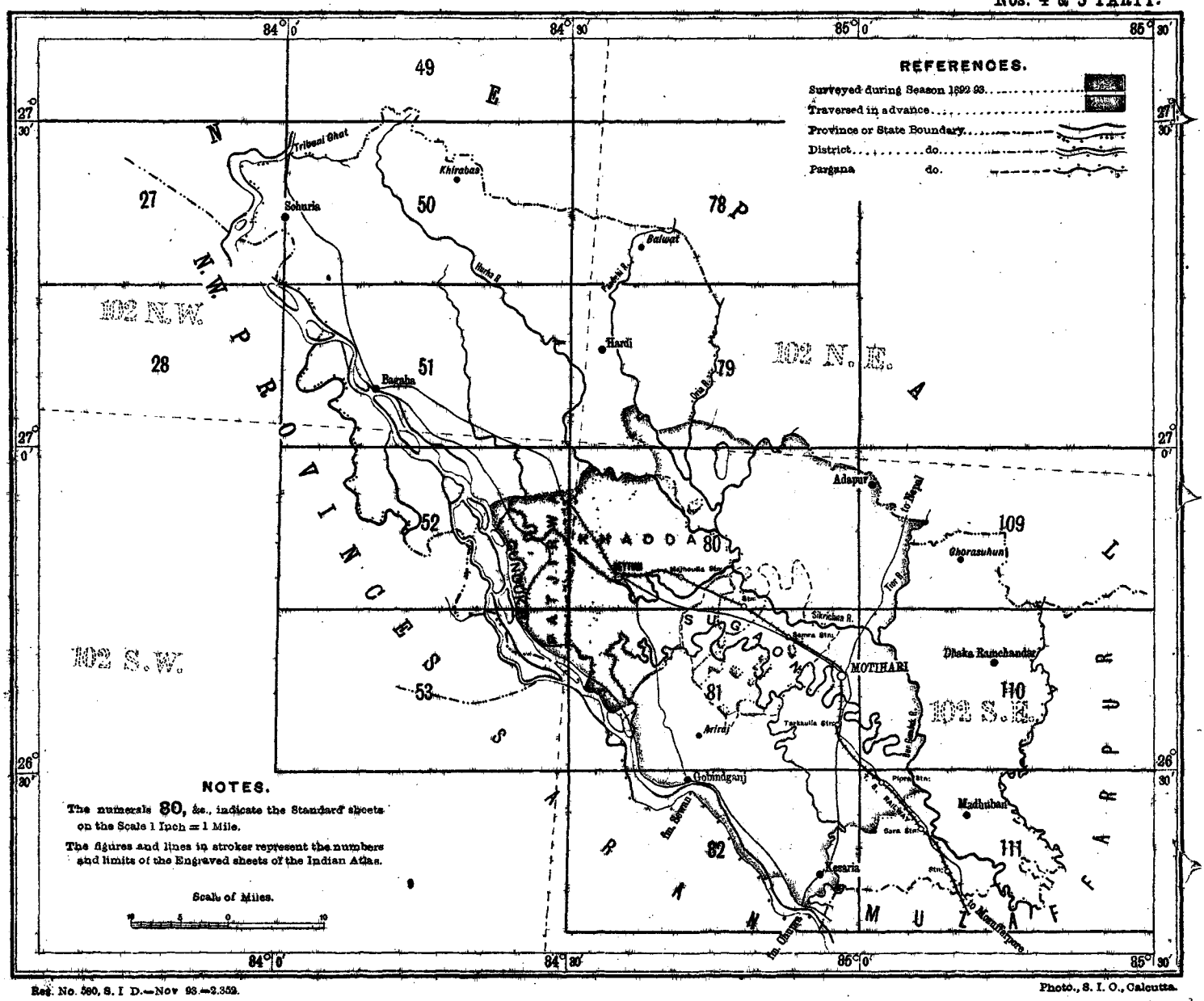
342. The records that were prepared in the field prior to submission to the Settlement Officer for attestation were—(*a*) a trace of the map in outline, (*b*) the *khasra* complete with areas and page totals, but without the details of areas by harvests, (*c*) the *khatians* complete with areas in acres and *bighas*, (*d*) the counterfoils of the *parchas*, (*e*) the *khewats* of proprietors and tenure-holders, and (*f*) the dispute lists. The counterfoils of the *parchas* were completed with areas and presented to such of the *zamindárs* as applied for them.

343. The physical features of the country for the most part presented no difficulties, with the exception of the vicinity of the town of Hajipur and a strip

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT CHAMPARAN.

Nos. 4 & 5 PARTY.



Reg. No. 580, S. I. D.—Nov 93—2,352.

Photo., S. I. O., Calcutta.

of land, about 2 miles wide, along the bank of the Ganges, where the country is one mass of groves of fruit-trees and gardens, and was extremely difficult to survey.

344. A cause of great delay at the commencement of the season was the difficulty experienced in finding the theodolite stations intermediate between tri-junctions in the area of Chakla Garjaul which was traversed by Colonel Barron's party in 1885-86. They were marked with locally-made pottery cylinders, and those that were traced were generally found very deeply buried; but as a great many could not be found at all, two traverse surveyors were employed almost till the end of the field season in laying down fresh stations and in adding sub-traverses where they were required.

345. The health of the party has been on the whole very good, although the field season extended to the end of June nearly. The season was, however, exceptionally cool owing to the unusually large amount of rain that fell during April and May.

346. During the ensuing season, another cadastral section will be transferred from Orissa to this district, and 1,000 square miles will be cadastrally surveyed comprising the whole of the *thanas* of Katrah and Belsund, and the *parganas* of Gadesar, Ratti, Saresa, Kasma, Bochaha, Morwa Khurd, Morwa Kalan, and portions of Bisara, Chakla Garjaul.

Survey of the Champaran District.

347. The traverse survey of this district was carried out by a section under Mr. G. G. Vander Beek, which was transferred from the Cuttack district, where it had been employed during the previous season, and which arrived at Muzaffarpur on the 24th October 1892.

Personnel.
No. 2, TRAVERSE SECTION.
Mr. G. G. Vander Beek, Extra Assistant Superintendent, 4th grade.
Mr. W. H. D. Ewing, Sub-Assistant Superintendent, 1st grade.
Mr. H. H. B. Hanby, Sub-Assistant Superintendent, 3rd grade, up to 1st February 1893.
22 sub-surveyors.
15 computers.

348. By the end of March 1893 an area of 1,103 square miles had been traversed, comprising the whole of the Motihari sub-division (with exception of *tappas* Nanaura and Maisi) and *tappas* Babta and Balthar of the Bettiah sub-division. The camp then moved into Saran district.

The following is a statement of the out-turn:—

DISTRICT.	TRAVERSE SURVEY.			
	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Champaran	697	1,145	18,372	1,103

349. The plots of 190 square miles of the Sugaon *tappa* were handed over, as soon as they could be got ready, to the cadastral section, as the area that had been prepared for survey during the previous season was only 363 square miles.

350. The number of linear miles of main and village traverses including sub-traverses is 4,089. The traverse work was connected with five stations of the N. E. Longitudinal series of the Great Trigonometrical Survey for the purpose of checking the chain measurements, and the angular work was checked by 108 observations for azimuth. The error per mile of the chaining in comparison with trigonometrical distances is 3·8 feet.

351. Pottery cylinders were used exclusively in this district for marking the traverse stations. The number of large cylinders embedded is 1,155 and of small ones, 16,821, giving an average of 1·2 of the large and 18·0 of the small per square mile. Here also one adjoining station, as well as the village tri-junctions, was marked with large cylinders at the commencement of the season.

352. The cost-rate of the traverse survey including stone embedding is R27·8 per square mile.

353. As in the Muzaffarpur district, the cadastral survey was commenced under very disadvantageous circumstances. The area to be surveyed consisted almost entirely of the Bettiah estate, and it was intended that the survey and records should be done by *patwáris* or substitutes provided by the *patwáris*, and the manager was requested and agreed to send 250 men for training to Motihari during the rainy season of 1892, and the training was entrusted to Mr. T. Shaw, Sub-Assistant Superintendent, who was also in charge of the Burdwan detachment. Unfortunately this officer's health broke down, and the orders regarding the training which had been given to him personally by the Director were not properly carried out, and only 180 men were trained instead of 250 as had been intended. Consequently a training class had to be continued during half tne field season, and the full establishment could not be employed from the commencement. The total number of men sent for training, including those trained during the field season, is 383, of whom the number of actual *patwáris* is 33. Of the substitutes, 186 were relations of *patwáris* of the area under survey, and 164 were men from other localities who were unconnected with the villages under survey.

Personnel.

No. 2, Cadastral Station.

Mr. R. B. Smart, Extra Assistant Superintendent, 3rd grade, from 3rd December 1892.
Mr. P. C. H. Smart, Sub-Assistant Superintendent, 1st grade.
Mr. N. Bedford, Sub-Assistant Superintendent, 2nd grade, from 27th November 1892.
27 inspectors.
383 *patwáris* and *madadgars*.
50 *khatian muharrirs*.
6 computers, etc.
6 draftsmen.
13 *muharrirs*.

354. The area of survey completed during the season is 416 square miles, and is distributed as follows:—

Tappa Khanda, 275 square miles, Patjerwa 87, and Sugaon 54.

The details of the out-turn of cadastral survey and record-writing is given in the following statement:—

District.	Cadastral Survey. 16 inches=1 mile..			Khanapuri.			Remarks.
	Number of villages.	Number of fields.	Area in square miles.	Number of villages.	Number of fields.	Approximate area in square miles.	
Champaran	265(*a*)	359,644	416	245(*b*)	274,979	320	(*a*) 21 incomplete. (*b*) 11 do.

355. The average size of the fields is 0·74 of an acre and the mapping is contained on 631 sheets. The detail survey was tested by 500 linear miles of check survey run by European assistants and 1,400 linear miles by inspectors, which gives an average of 4·6 linear miles of check work to each square mile of survey.

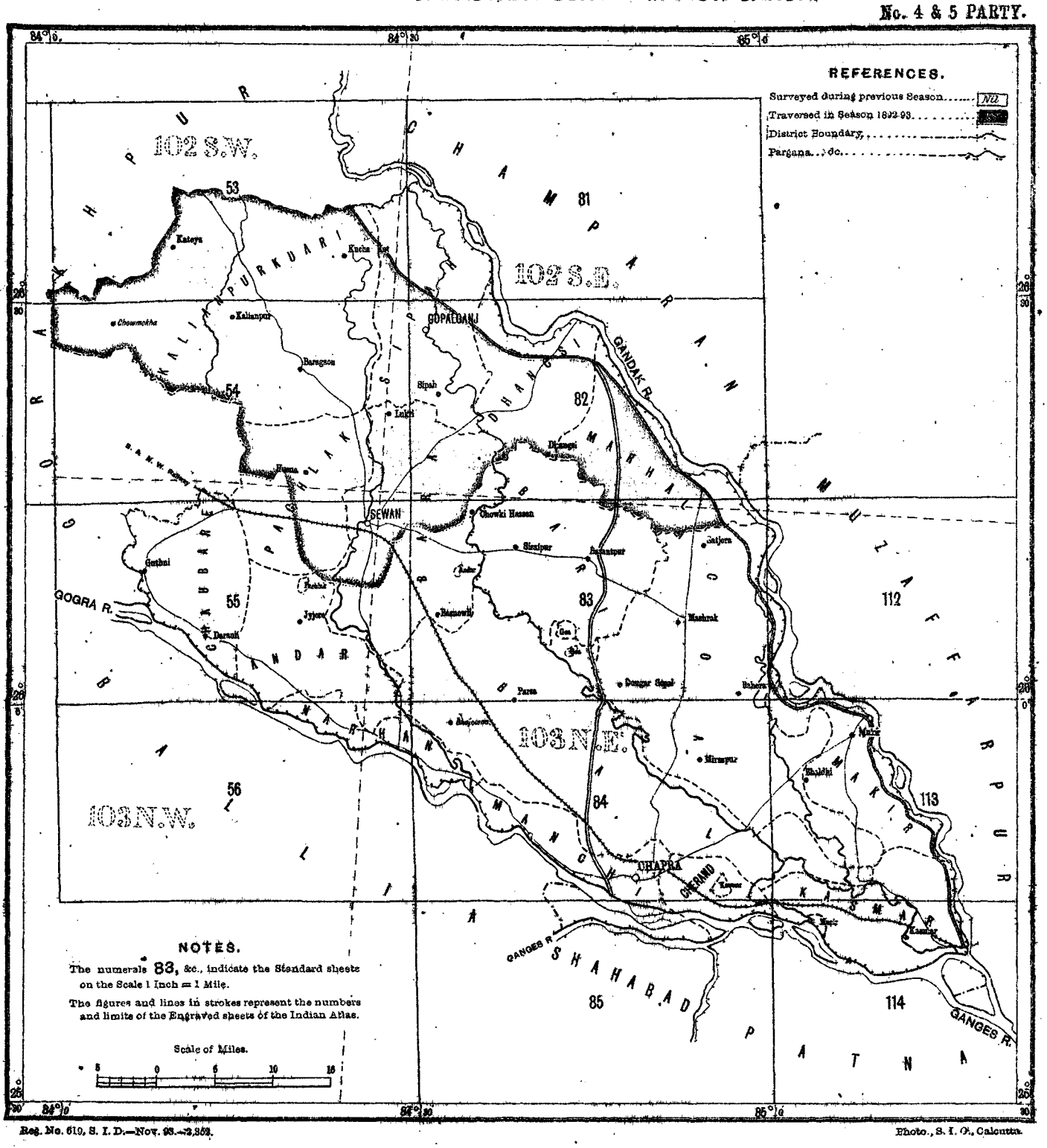
356. The cadastral section with its office establishment and equipment had to be formed at the commencement of the field season. The office establishment was entertained locally as required, most of the hands being new to the party and their qualifications unknown. The professional field establishment, which consisted only of inspectors, was formed out of the men who had been employed during the recess in training the *patwáris*. The majority of them proved to be quite unfitted for the arduous and responsible duties demanded of them as inspectors; but once the field season had begun, and the establishments had been entertained, other men could not be obtained, so these men had to be kept on. A few *amins* from the Muzaffarpur cadastral section were transferred to act as inspectors later on in the season, as well as several inspectors from the party working in the Cuttack district, but, with a few exceptions, they did not prove to be any better than the men they had replaced.

357. The office of *patwári* in Champaran is hereditary, and as *patwáris* are paid by the *zamindárs*, no pressure that could be brought to bear on them by

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. SARUN.

No. 4 & 5 PARTY.



Reg. No. 619, S. I. D.—Nov. 93.—2,352.

Photo., S. I. O., Calcutta.

the Survey officers had the least effect in inducing either them or their substitutes to work. In addition to this want of control, the manager of the Bettiah Raj had arranged to pay all men employed on the survey 4 annas per diem while so employed, with an allowance of 8 annas for four coolies, and this amount was paid them direct by the Raj or by the *thikadar* of the village under survey, whether they did any work or not. This fact and the very inferior quality of the inspectors necessitated most unceasing activity on the part of the assistants.

358. As the work was found to be progressing extremely slowly under these conditions, an arrangement was made with the manager in March that all payments to the field surveyors should be made through the survey camp officer, and an out-turn of 8 acres a day of survey and 25 numbers of *khanapuri* was fixed at first as the minimum which would entitle each man to receive his full 4 annas a day, the payments being made at regular intervals on receipt of reports from the inspectors giving each man's out-turn. As the men improved and gained confidence in themselves, the figures were raised to 10 acres a day of survey and 50 numbers of *khanapuri*.

359. Throughout the season reports were furnished to the Settlement Officer and to the Manager of the progress of the work, and the names of all men who absented themselves as they constantly did without asking for leave, and of those who were not exerting themselves properly; but, notwithstanding, several of the men persisted in absenting themselves and in doing their work as leisurely as it pleased them, and it is mainly owing to this that the full area of 500 square miles of survey and *khanapuri* was not completed. One great cause of the *patwáris* so constantly absenting themselves is said to be that in most cases they or their substitutes were not residents of their own villages.

360. The expenditure on the cadastral survey was ₹31,086, of which ₹8,244 were for a special establishment employed in completing the work, after orders had been received from the Board for the dismissal of the *patwáris*. The balance is the cost of supervision as the work was done by the *patwáris* and their relations, and other men whose services were lent by the estate, which also bore the cost of the coolies. Owing to the summary dismissal of the *patwári* establishment, the work was left in a half finished state, and it is creditable to Mr. R. B. Smart that he was able to push it on to the extent which he has done. The cost is far greater than it would have been if the work had been completed, as it was begun, by the *patwáris*. The cost-rates per square mile are as follows:—field survey, ₹78·9; record-writing, ₹30·2, and instruction of *patwáris*, ₹7·0.

361. The full field establishment of inspectors and *madadgars* was dismissed towards the end of June, when the rains began, and the assistants and office establishment moved to recess quarters at Motihari, after arrangements had been made for each *patwári*, whose circle had not been completed during the field season to gradually bring up his map and records during the recess. Two inspectors were retained to see that the men worked, and to give them assistance when necessary.

Survey of the Saran District.

362. Towards the end of March 1893, both the traverse sections which had been employed in the Muzaffarpur and Champaran districts, moved into the Saran district and traversed an area of 894 square miles, comprising the whole of *parganas* Kalianpur, Kuari and Sipah, with the exception of the *diara* area lying between the embankment and the Gandak river, and portions of *parganas* Pachlak and Bara.

363. The out-turn of traverse survey is shown in the following statement :—

District.	Traverse Survey.			
	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Saran	1,927	1,220	19,161	894

364. The work was connected with five stations of the Harilaong Meridional series of the Great Trigonometrical Survey, and the average error in chaining is

6·09 feet per mile. The angular observations were checked by azimuth observations at 99 stations. The stations and data of the Gorakhpur survey of 1885-86 have been utilised where the present work touched on it. A few new stations had to be interpolated where the old marks had disappeared.

365. In this district, the tri-junctions only have been marked with the large 8-inch cylinders, and the number of these embedded is 3,661, or 4·1 per square mile. The number of small cylinders embedded is 15,500, or 17·4 per square mile.

366. The cost-rate of the traverse survey including demarcation and stone embedding in this district is ₹38·6 per square mile.

Survey of the boundary of the Ghora, alias *Katora*, *Government estate, Patna district.*

367. As Messrs. Gillanders, Arbuthnot and Company had applied for a lease of the Government estate known as Ghora, *alias* Katora, to prospect for minerals, and the *maliks* of Sithoura, *alias* Chand Kola, a village on the north, claimed a portion of the hill where gold had been discovered, the Board recommended that a survey of the boundary of the estate and of the *mauzas* forming its northern boundary should be taken up under section 45, Act V (B.C.) of 1875. The survey was sanctioned in Government letter No. 1121T.R., dated 23rd March 1892, to the Board, and the expenditure of ₹300 in Government letter No. 1159T.R., dated 11th March 1893.

368. Lieutenant Pilcher, R.E., was deputed to make a skeleton boundary survey on the 4-inch scale. The work was commenced on 15th March and completed on 26th April 1893. The result shows the new map boundary to be identical with that of the old revenue survey boundary of 1842. This boundary has now been demarcated on the ground by stone marks at salient points and by cairns of stones at intermediate bends. The Sithoura *malik's* claim has also been demarcated on the ground.

369. The Director of Bengal Surveys reports that Captain G. B. Hodgson, who has been in charge of these operations in North Bihar, has had an arduous and difficult post, and has performed his duties well. The relations between the Survey and Settlement authorities have been very cordial, which Captain Hodgson says is in a great measure due to the tact and discretion with which the Settlement Officers exercise their authority with the members of the Survey Department, and to the good spirit with which the latter accept their new position of intimate association with the revenue officers. Captain Hodgson expresses his acknowledgments to the Collectors of Muzaffarpur, Champaran and Saran, and to the Subdivisional Officers of Bettiah, Sitamarhi, Hajipur, Siwan and Gopalganj. He reports that the planters of the district were always ready to assist, and all members of the party invariably met with courteous treatment at their hands.*

ASSAM.

No. 6 Party.

370. The main party, under Mr. E. C. Barrett, left recess quarters at Shillong on the 5th November 1892 for Sylhet, where the field offices were established and survey operations were carried on in the Jaintia *parganas* till the 5th May 1893, when the party returned to Shillong for the recess. A small detachment proceeded to Kamrup for the survey of the town of Gauhati.

Personnel:

Mr. E. C. Barrett, Superintendent, 2nd grade, in charge up to 28th April 1893.
Mr. A. J. Gibson, Extra Assistant Superintendent, 2nd grade, from 17th November 1892, and in charge from 28th April 1893.
Mr. W. H. Penrose, Extra Assistant Superintendent, 6th grade, from 9th June 1893.
Mr. J. Smith, Sub-Assistant Superintendent, 2nd grade.
17 sub-surveyors and others.

Temporary Establishment.

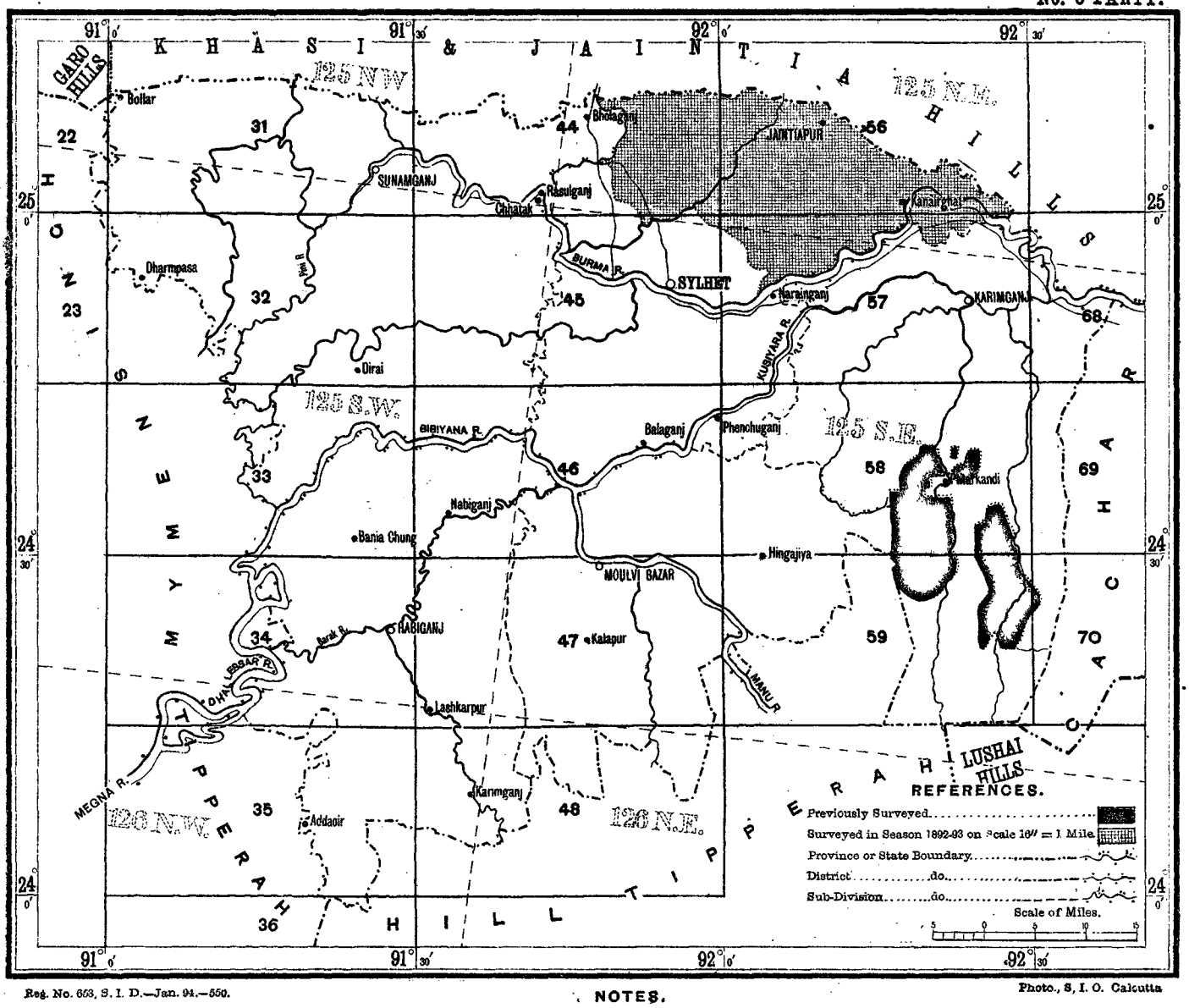
76 supervisors, inspectors, draftsmen, computers, etc.
46 field surveyors (imported).
55 *mandals* (local).
84 field surveyors (local).

* Captain Hodgson reports that the newly joined officers, Lieutenants Pilcher and Symonds, have displayed intelligence and great interest in their work, and that all his assistants did well, making special mention of Messrs. H. T. Hanby and R.B. Smart.

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT SYLHET.

No. 6 PARTY.



Reg. No. 663, S. I. D.—Jan. 94.—550.

Photo., S, I. O. Calcutta

NOTES.

The numerals **46**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

No. 217-S. 94.

371. The season's operations comprised—

(*a*) completion of traverse survey of the Jaintia *parganas* commenced in the previous season;

(*b*) cadastral survey on the 16-inch scale of the Jaintia *parganas*;

(*c*) traverse and cadastral survey on the 32-inch scale of Gauhati town.

372. As the area allotted for survey during the season was considerably smaller than that of the previous season, the permanent establishment was reduced by one European assistant and three sub-surveyors, and a temporary establishment of sufficient strength was retained to ensure the completion of the Jaintia *parganas*.

373. A survey class was established early in October at Sylhet, under Mr. J. Smith, for the instruction of candidates, with the result that 95 went through a course of training; of these, 58 were entertained as field surveyors, 24 were granted certificates, and 13 were disqualified. In addition to the above, the following Assistant Commissioners received instruction and qualified in surveying, *viz.*, Messrs. Hallifax, Ezechiel, Howell, Halliday, Cole and Lees, and also six Deputy Collectors, one *tahsil muharrir*, and one *tahsildar*.

374. From 40 to 50 per cent. of the old marks at the tri-junctions of villages having disappeared, stone prisms, measuring 3 feet in length, were erected in their places. All theodolite stations were indicated in the usual manner, *i.e.*, by *simal* and other boughs planted 5 feet north of the point at which the instrument was set up. Around these boughs, mounds of earth, 3 feet high and 6 feet in diameter, were erected and protected by a bamboo casing to preserve them from cattle and from being washed away by heavy rain.

375. The cadastral survey was carried on by sub-surveyors, Bengali and local *amins*, including candidates who had passed through the survey school, with a few Assamese *mandals*. The work done by Assistant Commissioners, Sub-Deputy Collectors and others, who were qualifying in surveying, was also utilised. The work performed by local *amins* who had received instruction in the survey school was of fair quality, and in future survey operations there should be no difficulty in obtaining a supply of trained men.

376. The average daily outturn of different classes was as follows:—

	Acres.
Hindustani field surveyors	19·93
Bengali ditto	16·97
Local ditto (old)	14·02
Do. ditto (new)	10·62

377. The following statement gives the season's outturn in traverse and cadastral survey:—

Districts.	Traverse Survey.			Cadastral survey.			Remarks.
	Number of villages.	Number of sub-traverses.	Area in square miles.	Number of villages.	Number of fields.	Area in square miles.	
Sylhet (Jaintia)	162	60	153·00	550	257,665	484·33	16-inch scale.
Kamrup (Gauhati town).	3	6	3·44	2	3,633	3·44	32-inch scale.
Kamrup (river blocks).	...	...	2·20	...	...	...	
Total S	165	66	158·64	552	261,298	487·77	

378. The cadastral work was checked by 1352·6 linear miles of *partal*, giving an average of 2·8 linear miles per square mile of survey. The amount *partalled* by European assistants and inspectors was respectively 132·8 and 1219·8 linear miles.

In the village records the entries of 55,651 fields were examined on the ground, of which 9,313 were tested by Mr. Smith; a staff of Sub-Deputy Collectors, specially appointed to test these entries, was also employed throughout the season.

379. The average cost of the cadastral survey, including traverse, detail survey, mapping, and completion of records and statistics, amounts to R126·3 per square mile in Sylhet. The reasons for the increased cost this year are (*a*) the small area allotted for survey, and (*b*) the employment of inexperienced local field surveyors who, not being salaried Government servants, were paid at contract rates almost double those given to the *mandals* of the Assam Valley.

380. The work has been mapped on 668 sheets, which include Jaintia and Pratabgarh in Sylhet and Gauhati town in district Kamrup. Tracings of the above, together with the village records, have been made over to the Settlement Department.

381. The revision survey of the previous year's work in the Assam Valley employed 15 *amins* during the field season, after which they were gradually reduced. This work was under the superintendence of Mr. J. H. O'Donel, who had been deputed from the Survey Department to the Assam Government for settlement work; he was assisted with the loan of six computers from the Survey Office, and the work was completed just before the end of the recess. In Pratabgarh, Sylhet district, one sub-surveyor and one *amin* were placed at the disposal of the Assistant Settlement Officer for the same purpose. The expense of these establishments was borne by the Survey Department.

382. Mr. Barrett has recorded his appreciation of the assistance rendered by the Deputy Commissioners of Gauhati and Sylhet, the Settlement Officers, Assam Valley and Jaintia, and other officials.

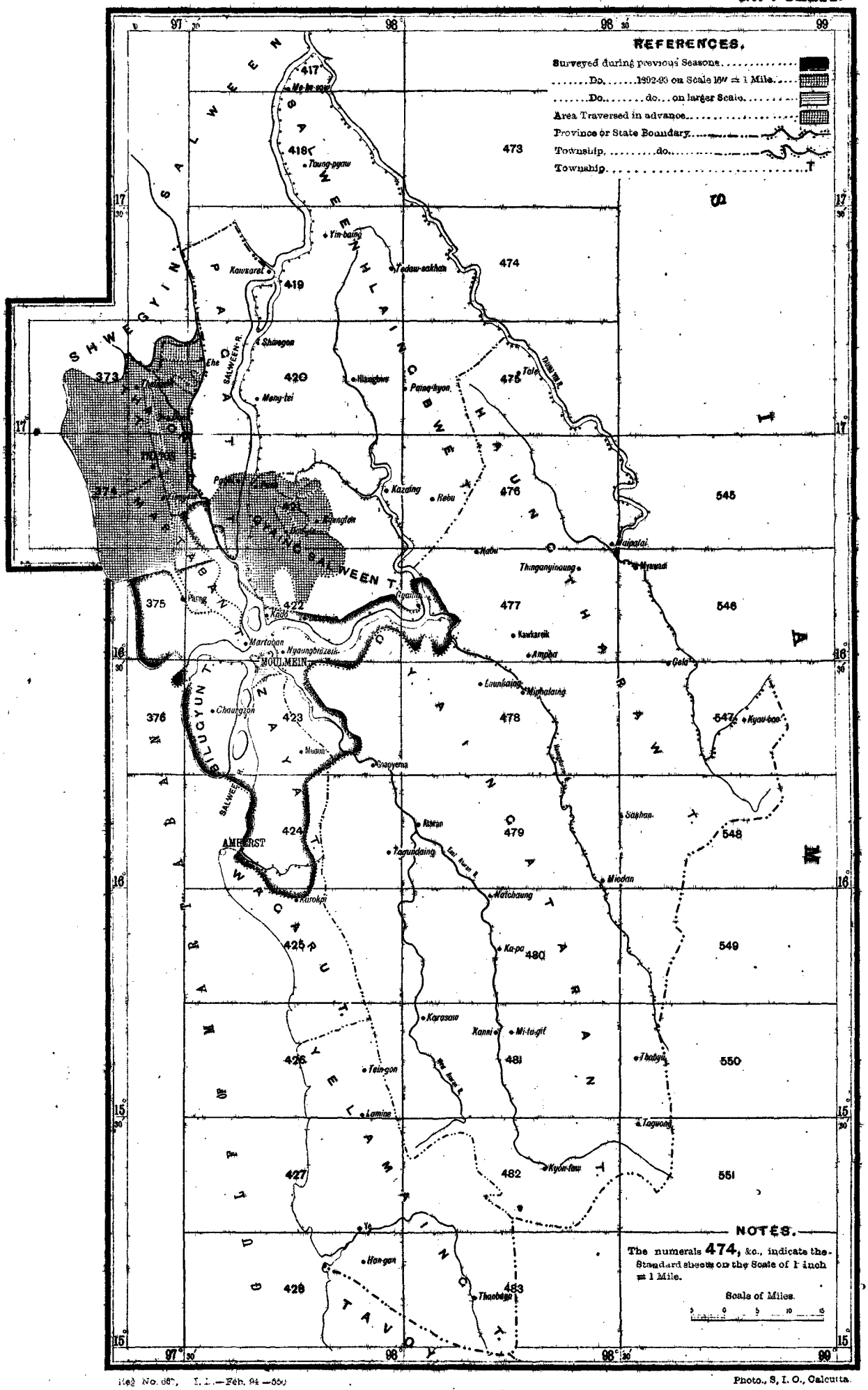
383. This party was visited twice during the year by the Deputy Surveyor-General—once in March during the field season, and once during the recess. In March he visited the field head quarters at Sylhet, and thence went into camp and inspected several *amins* whilst actually at work, checking their maps on the ground. It was satisfactory to find that instead of the expected opposition to the surveyors on the part of the villagers, each field surveyor was followed about by a small crowd of men anxious to point out the boundaries of the fields and to render all the assistance necessary to make a correct map. In June the recess office under Mr. Gibson was inspected, and arrangements were made for the temporary increase of the recess establishment, if found necessary, to ensure the completion of the records, so that they might all be submitted before the departure of Mr. Darrah, the Director of Land Records, who was to be transferred in November to the North-West Provinces. The Deputy Surveyor-General reports that the work, both in the field and in the recess, was good and accurate, and that Mr. Gibson is deserving of praise for the way in which he has carried out the completion of the records during the recess. The Chief Commissioner was also consulted as to the possibility of employing the party during 1894-95, but nothing definite could be decided at that time. It was afterwards arranged, under the orders of Government conveyed in No. 1876-102, dated 3rd August 1893, to the Chief Commissioner of Assam, that the survey of the Cachar district will be commenced during the coming field season; and it is proposed to complete the traverse of 400 square miles and the cadastral survey of 150 square miles in that district, besides carrying on the revision surveys of the Jaintia *parganas*. *

* During Mr. Barrett's absence on leave for six months, Mr. A. J. Gibson held charge of the party and was very successful in carrying on the recess duties. Mr. W. H. Penrose was transferred to the party early in the recess season, and rendered efficient assistance in bringing up the work. Mr. J. Smith also worked well. Of the natives, the officer in charge specially mentions Sakhawat Hossein, Khorshed Hossein, Mahomed Tabrez, Krishnajee Mahadeo, Futteh Mahomed, Jhuni Lall, Bahadur Singh, and Janardan Rao.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT AMHERST.

No. 7 PARTY.



Reg. No. 66, I. I.—Feb. 94—550

No. 236-S. 94.

AMHERST, TAVOY, MERGUI, AND SHWEGYIN DISTRICTS, LOWER BURMA.

No. 7 Party.

384. This party was employed during the season in the Amherst, Tavoy, Mergui and Shwegyin districts, as mentioned in paragraph 281 of the Annual Report for 1891-92; but the expectations therein expressed, of completing the work in the three first-named districts, could not be realised, except as regards Tavoy, for owing to the abnormal difficulties encountered at Mergui, and the very early setting in of the rains all over Lower Burma, about 70 square miles of detail survey in Mergui and about 50 square miles in Amherst remained unsurveyed. The conduct of the traverse and cadastral operations in Tavoy and Mergui was entrusted to Mr. Jarbo; while the topographical survey of the coal-fields was placed in the hands of Mr. Gastaud. The work in Amherst lay in two localities, widely distant from each other—that in the Thaton township (from which it was intended to extend into Shwegyin) was entrusted to Mr. Littlewood, while that in the Gyaing-Salween township, together with the survey of Moulmein town and of the revisions called for by the Settlement Department, were placed in the hands of Mr. Price.

Personnel.

Mr. C. Wood, Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. H. R. Littlewood, Assistant Superintendent, 1st grade.
Mr. W. C. Price, Extra Assistant Superintendent, 4th grade, from 13th December 1892.
Mr. R. B. Smart, Extra Assistant Superintendent, 4th grade, up to 21st December 1892.
Mr. G. W. Jarbo, Extra Assistant Superintendent, 5th grade.
Mr. J. Murphy, Extra Assistant Superintendent, 6th grade.
Mr. M. Gastaud, Sub-Assistant Superintendent, 1st grade.
Mr. T. W. Babonau, Sub-Assistant Superintendent, 2nd grade, from 3rd January 1893.
Mr. F. B. Powell, Sub-Assistant Superintendent, 2nd grade.
Mr. W. H. Biggie, Sub-Assistant Superintendent, 3rd grade, up to 6th January 1893.
27 sub-surveyors and others.

Temporary Establishment.

80 inspectors, draftsmen, computers, etc., etc.
107 field surveyors.

385. In order to push on the traverse and to utilise all available fine weather, five sub-surveyors left for Tavoy and Mergui on the 17th October: the European assistants and remaining traverse surveyors left a fortnight later, and field surveyors were on their ground between the 15th and 20th December. The traverse section for Amherst left Rangoon on the 1st November; and the entire cadastral establishment, with the European officers and head-quarters' camp, followed on the 29th idem. Rain commenced to fall on the 23rd April, but the party, in hopes of a break, was kept on the ground until the 25th May, when field work was finally closed: the recess quarters were reached on the 2nd June.

386. The work of the season comprised the following operations:—

In Amherst, (i) the traverse survey of 385 square miles in the Martaban and Gyaing-Salween townships; (ii) the cadastral survey on the 16-inch scale of 688 square miles in the Pagat, Martaban, and Gyaing-Salween townships; (iii) the survey of the Thaton Municipality, $3\frac{1}{2}$ square miles, on the 32-inch scale; (iv) the revision of the old survey of Moulmein, about 9 square miles, on the scales of 50 feet, 200 feet, and 400 feet to the inch for the town, cantonment, and environs respectively; (v) the numerous revisions in the work of 1891-92 called for by the Settlement Officers.

In Tavoy, the traverse or boundary survey of 39 square miles and the cadastral survey of 88 square miles in the four townships of that district.

In Mergui, (i) the boundary survey of 225 square miles in the Palaw, Tenasserim, Mergui, Lenya, and Maliwun townships; (ii) the cadastral survey of 127 square miles in the four first-named townships; and (iii) the topographical survey on the 1-inch scale of 610 square miles in sheets 563, 579, and 580, tracings of those portions bearing on the routes from the coal-fields being supplied, as the work progressed, to the Deputy Superintendent of the Geological Survey for immediate use.

In Shwegyin, the traverse survey of 180 square miles in the Bilin and Kyaikto townships.

387. Settlement operations, as in 1891-92, were continued in Tavoy and Mergui by a *myook* and his staff of holding-markers, working under the direction of this party: these were immediately followed by the revision surveyors as before. Owing however to the difficulty of getting the attendance of the owners

of gardens who lived many miles away from their ground, the *myook's* progress was somewhat slow, and the Settlement Officer, who had thrown in too large a number of inspectors, became impatient for results: on his representation the entire staff of holding-markers was transferred to him in February last, but whatever may have been the benefit of this change to the Settlement Department, it proved very disadvantageous to the survey operations, for it caused much delay in the revision work, and in consequence 61 *kwins* in Tavoy and 139 *kwins* in Mergui still have to be revised: these the Director of Land Records and Agriculture has ordered to be left for the supplementary survey party to do.

388. The want of demarcation in large forest tracts in Amherst was sorely felt by the party. In the Danu circle of this district there was absolutely no demarcation in about 170 square miles, nor could the number or position of the *kwins* that lay buried in forest be ascertained with any certainty from the local officials: this led to considerable loss of time in reconnoitring the ground, and having rough maps made as a guide for laying out work, with the result that several more *kwins* were found than were given on the Sub-divisional Officer's list. The demarcation of gardens on the Martaban range was very defective in parts; but the Settlement Officer himself being near at hand, the local officials and villagers were compelled by him to render assistance where necessary. In Tavoy, the unwillingness of the *thugyis* and *yua-thugyis* to assist in completing the demarcation of the hill gardens was again experienced, and the Deputy Commissioner's help had to be resorted to. In Mergui, the representations of the executive officer to the Deputy Commissioner were productive of so much energy on the part of the *myooks* and their subordinates in certain localities that several more *kwins* were found for survey in circles of which the demarcation maps had already been received and the traverse survey completed in 1891-92. No demarcation maps were ever received for the Lenya and Bokpyin circles, and the survey was carried out with the help of the topographical 1-inch sheets. In Shwegyin, the demarcation maps of some circles were very late in coming to hand, and up to the date of closing operations those for three of the circles required had not been received: this was productive of some inconvenience in laying out the work, and in consequence the main circuit could not be completed.

389. The traverse stations were marked as usual with pottery cylinders till towards the close of the season, when, owing to the failure of the contractor who supplied them, galvanized iron ones, similar to those used for two seasons by No. 12 Party, and referred to in paragraph 340 of the Annual Report for 1891-92, were substituted. The stations were handed over to the custody of the *thugyis* and *yua-thugyis*, but they hardly seem to realise that the care of these stations is really part of their legitimate duties. For the ensuing season the Director has approved of the permanent marking of the traverse stations being limited, the tri-junctions with their contiguous stations and two or three suitable intermediate stations being marked with pottery cylinders, while about an equal number of other stations are to be marked with galvanized iron cylinders. The remaining stations are to be only temporarily marked.

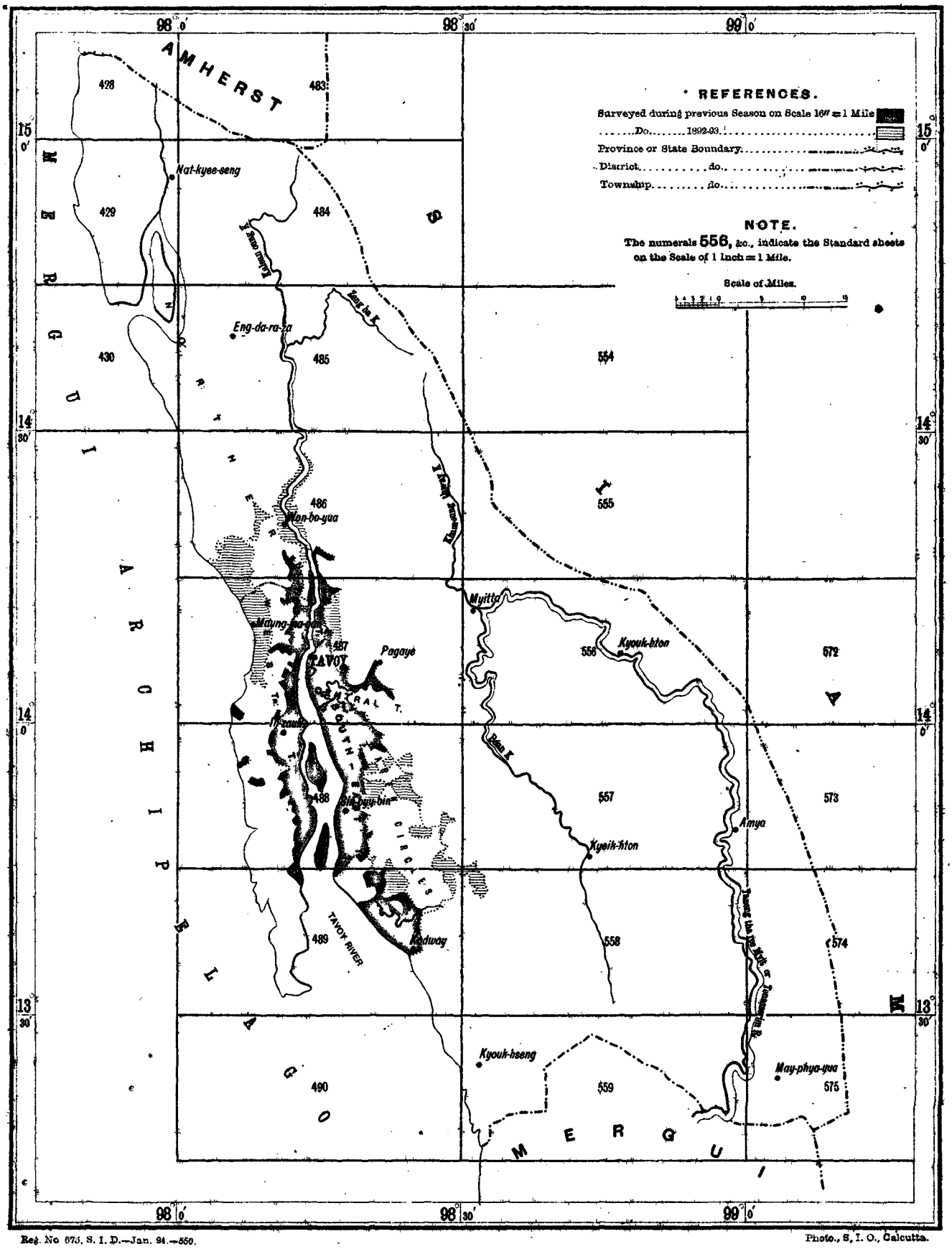
390. The following statement shows the outturn of the season's work:—

Districts.	Traverse survey,		Cadastral survey, 16 inches = 1 mile.				Town surveys.		Topo. survey,
					Area in square miles.		Area in square miles.		Area in square miles.
	Number of *Kwins*.	Area in square miles.	Number of *Kwins*.	Number of fields.	Cultivation.	Jungle.	Scale, 32 inches = 1 mile.	Scale, 1 inch = 50,200 and 400 feet.	Scale, 1 inch = 1 mile.
Mergui	322	225	344	53,877	58	69	...	...	610
Tavoy	31	39	75	19,783	15	73	...	...	...
Amherst	254	385	433	432,686	321	367	$3\frac{1}{2}$	$9\frac{1}{8}$	...
Shwegyin	138	180	...	...	...	...	...	...	...
Totals	745	829	852	506,346	394	509	$3\frac{1}{2}$	$9\frac{1}{8}$	610

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT TAVOY.

No. 7 PARTY.



Reg. No 675. S. I. D.—Jan. 94.—550.

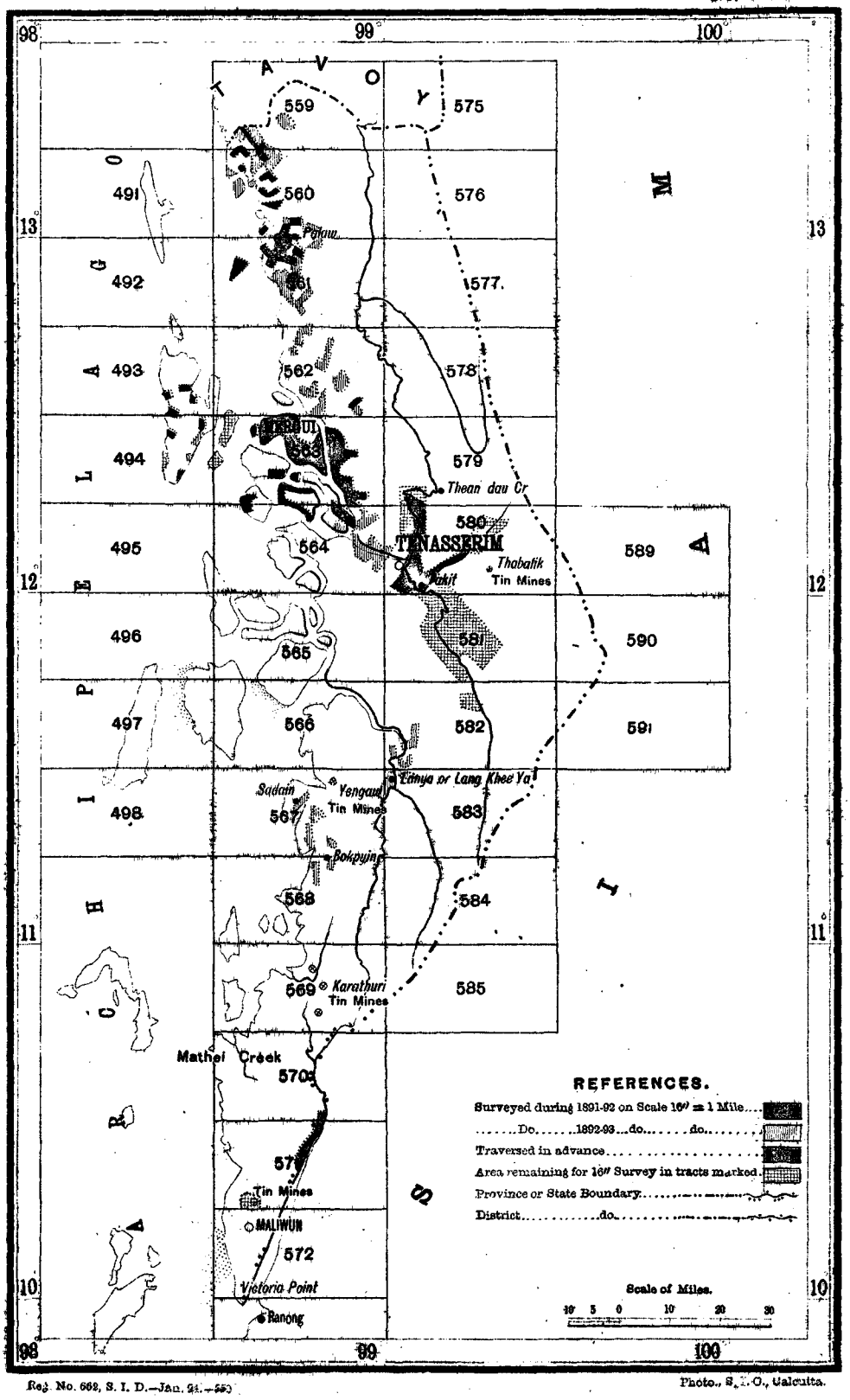
Photo., S. I. O., Calcutta.

No. 222-S. 94.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT MERGUI.

No. 7 PARTY.



Reg. No. 662, S. I. D.—Jan. 94.—55.

Photo., S. I. O., Calcutta.

No. 221-S. 94.

391. The detail survey on the 1-inch scale was tested by *in situ* fixings and found to be as accurate as could be expected in such country; that on the 16 and 32-inch scales was tested by 1,938 miles of chain measurements, of which 852 are either independent *partals* or final check lines run by Europeans.

392. It will be seen that the cultivation is four-ninths of the total area surveyed. The average size of the fields this year, reckoned on cultivation only, is in Amherst 0·47 of an acre, and in Tavoy and Mergui taken together it is 0·63 of an acre. Reckoning therefore that the expenditure in surveying 4 square miles of jungle is equal to that of 1 square mile of cultivation, the cost per square mile of 16-inch work for Amherst is R258 and for Tavoy and Mergui R252 per square mile: these figures are considerably in excess of those of the year previous, which were R186¼ and R216¾, respectively. The reasons for this increase in the Amherst district are (i) that both the camps were working with a reduced number of men, owing to the employment of several hands on the large scale surveys and on revisions, whilst the cost of superintendence remained the same; and (ii) because little or no work could be done during the last month on account of the early rainfall: this latter reason also held good in Mergui, and in addition to this was the delay caused in moving the men to the more inaccessible parts of the district; in one instance a squad of field surveyors was detained a fortnight, vainly endeavouring to find the means of getting round Victoria Point, and up the Pakchan river to Nunweh, and eventually when the steam launch was sent for the purpose, it had to return before proceeding half way because of the bad weather. The total cost of the Thaton town survey is R1,920 and that of the Moulmein town R7,918; the revision surveys cost R8,699, and the Mergui coal-fields survey R17,399: thus on all accounts, including demarcation, the cost of the operations has been R2,-0,203.

393. In accordance with the wishes of the Burma Government, Mr. G. D. Madgavkar, C S., was attached to the party during six weeks in March and April for instruction in surveying: he was accordingly familiarized with the use of the theodolite and plane-table, after which he carried out a small boundary survey of 250 acres and a cadastral survey of about one-half of the same; he was also instructed in the computations connected with his boundary survey, and in the calculation of the areas of the fields, etc., all which he had to do for himself.

394. The volumes of area statements of the Thongwa survey, referred to in paragraph 278 of the previous year's report, have been deposited in the Calcutta office; and the binding and indexing of the work in Amherst, Tavoy, and Mergui have been proceeded with.

395. The recess season's work has been heavier than usual. Owing to the continuous demand for revision surveys, the maps of the Amherst district for 1890—92, and of Tavoy and Mergui for 1891—93, nearly 2,900 in number, had all to be more or less re-examined and completed; of these, 1,900 were despatched to Calcutta by the 30th September, and the remaining 1,000 will all be probably disposed of before the party takes the field. In addition, the sheets of the Moulmein town survey entailed a large amount of labour. The drawing of the 2-inch sections of the Thongwa survey has been completed, and that of Amherst is well advanced. The usual 16-inch tracings of *kwin* maps, area statements, and 2-inch maps for the country surveyed during the year under report will be supplied to the Settlement Officer before the recess closes.

396. Opportunity has been taken of the presence of the party in Rangoon to bring up to date, without much expenditure, the preliminary sheets of the survey of the Rangoon Town district executed in 1883 on the 16-inch scale. It is hoped that five out of the 19 sheets will be finished this year, and the remainder in 1894. As might have been expected, numerous additions and alterations have been made since the date of the first survey.

397. The employment of Burmans and Karens as field surveyors has worked fairly well during the year. Fifty of these men were employed, *viz.*, 7 men who had previously received five-year certificates, 11 who during last season completed their fifth year of service, 10 their fourth year, and 7 their third year; also 15 others who, though not coming under Mr. Bridges' scheme of 26th February 1886, had, nevertheless, attached themselves to the party during the season in order to acquire a knowledge of field-surveying. With four

or five exceptions, the conduct of these men was generally satisfactory: their average outturn was found to be slightly larger than it was in previous years, and amounted to two-thirds of that of the Hindustani. The average monthly earnings of the men who served throughout the season is ₹32-11, as against ₹35-11 of the year before. This party has now had several years' experience of Burmans, and the opinion formed by the officers under whom they have been employed is that they are as a rule unreliable, and that, unless a close supervision is maintained over them, they are apt to diverge from the recognized paths of duty on the most trivial excuses, quite regardless of the inconvenience and expense thereby caused to Government.

398. The party was inspected by the Deputy Surveyor-General in the field in January 1893. On this occasion the work in Amherst, Tavoy and Mergui, including the coal-fields survey on the Tenasserim, was examined on the ground. A second inspection was made in recess in August and September, and many matters of detail were discussed in connection with the future working of the party. Both the fieldwork and the general state of the records were found to be in a very satisfactory condition.

399. As the survey of additional tracts in the Amherst district, aggregating probably 1,000 square miles, and a large scale (64 inches = 1 mile) survey of the Maliwun tin mines have been asked for by the Burma Government, the party will, during the ensuing season, probably find ample occupation in completing these two districts, as the tracts assigned for survey are very scattered; but should more work be needed during the field season, the detail survey of one or two of the southern circles in Shwegyin, where the boundary survey has been already done, will be taken in hand.*

ORISSA.

No. 8 PARTY.

400. This party remained under the charge of Lieutenant R. T. Crichton, S. C., till 24th April 1893; on which date he proceeded on leave preparatory to furlough; the charge then devolved on Mr. R. C. Ewing, Extra Assistant Superintendent. The operations have been in continuation of those of the previous year.

Personnel.

Lieutenant R. T. Crichton, Officiating Deputy Superintendent, 2nd grade, in charge up to 24th April 1893.
Mr. R. C. Ewing, Extra Assistant Superintendent, 4th grade, in charge from 25th April 1893.

Traverse Section.

Mr. C. S. Kraal, Sub-Assistant Superintendent, 1st grade.
„ J. P. Barker, Sub-Assistant Superintendent, 1st grade.
59 sub-surveyors, computers, etc.

Cadastral Sections.

Mr. R. C. Ewing, Extra Assistant Superintendent, 4th grade, up to 24th April 1893.
Mr. S. O. Madras, Extra Assistant Superintendent, 4th grade.
„ A. W. Smart, Sub-Assistant Superintendent, 1st grade.
„ E. F. Berkeley, Sub-Assistant Superintendent, 1st grade.
„ C. S. Gasper, Sub-Assistant Superintendent, 2nd grade.
Babu Nilmony Chatterjee, Sub-Assistant Superintendent, 3rd grade.
128 inspectors.
90 computers, draftsmen, etc.
482 field surveyors.
959 *khanapuri amins.*

401. The party was subdivided into four sections—one for traverse and three for cadastral survey. Of these, one traverse and two cadastral sections were employed in district Balasore, and the remaining cadastral section in district Cuttack.

Survey of the Balasore District.

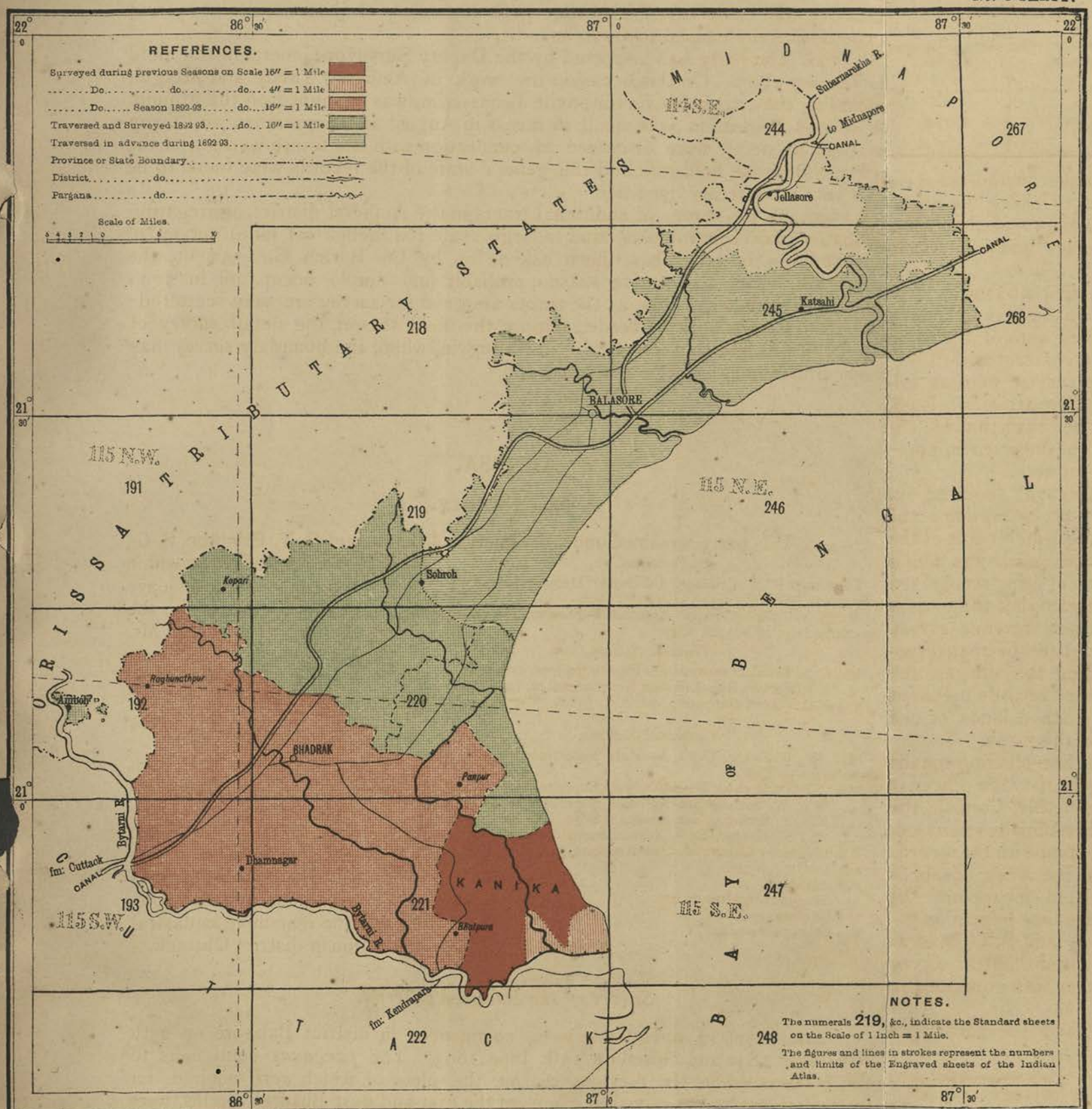
402. Traverse operations were commenced in district Balasore on 25th November 1892 and closed on 13th June 1893. The *parganas* contiguous to those traversed in the previous season, the plots of which were required for immediate use by the cadastral camps of the east and west Bhadrak circles, were

* The executive officer speaks very highly of the manner in which his senior assistants, Messrs. Littlewood, Price, Jarbo and Murphy, carried on their work, sometimes under exceptional difficulties. Mr. Gastaud, too, is commended for the good work he did in Mergui under many disadvantages. Of the permanent native establishment, the following are specially commended:—C. Abrew, Shoshi Bhusan Ghosal, Hidayatulla, Azimulla Khan, Faiz Baksh, Mahomed Husain I, Mahomed Umar, Mahbub Ali, Basesardyal, Inamulla Khan, Wajid Ali, Maung Hpo Kyone, and Maung Hpo Kah.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY OF ORISSA, DIST. BALASORE.

No. 8 PARTY.



Reg No. 591, S. I. D.—Nov. 93.—2,363.

Photo., S. I. O., Calcutta.

first taken up, and then the other *parganas* in the north were proceeded with until the district was finished.

403 The season's traverse operations cover an area of 1,074 square miles. Of this area, 462½ square miles have been surveyed cadastrally, and thus 611½ square miles are ready in advance for the field survey of next season, plus 13 square miles of villages permanently settled in *pargana* Bhograi.

404. The extent of work of the traverse section is detailed in the following statement:—

District.	Number of villages.	Number of sub-traverse.	Number of traverse stations.	Area in square miles.
Balasore	2,366	1,480	34,290	1,074

405. Five thousand one hundred and forty-two linear miles of traverse were run. Two hundred and forty-one azimuths were observed to check the angular work. Eleven stations—four principal and seven secondary—of the Great Trigonometrical Survey were connected with the traverses and the chain measurements corrected thereby.

406 There were 33,450 stations permanently marked, *viz.*, 2,641 with large tri-junction stones, 2,407 with smaller stones, 28,230 with baked clay cylinders, while 172 stations on rocks were marked *in situ*: the stones were of the same sort as used during previous seasons, supplied by the same contractor.

407. The cost-rates per square mile for the traverse survey were as follows: traversing ₹35·0, stone-embedding ₹9·3, and demarcation ₹2·8, giving a total rate of ₹47·1. This rate is considerably higher than that of the previous year, which is due to the expenditure which had to be incurred in completing the arrears of computations of the previous season's work.

408. The unit of the traverse survey was the "existing *mauza*" (pointed out by the people on the ground) as distinct from the revenue survey *mauza*: the former was plotted on the 4-inch scale, and compared with the 4-inch maps of the previous revenue survey of 1841. When a revenue survey *mauza* was found to have been sub-divided into two or more parts (each at present being recognised as a *mauza*), the local name of each part is permitted to remain, but the remark is made on each map that it is a portion of such and such revenue survey *mauza*: when two or more old revenue survey *mauzas* have been incorporated into one, due probably to the same *zamindár* owning the villages, the separation has been effected in the cadastral sheet maps and records prepared separately for both *mauzas*. "*Tahsil atahida*" lands (detached lands of one village lying within another) have been separately shown on the maps.

409. The progress of the work was uniformly good, as line-clearing squads preceded the surveyors; the people were found willing to help after the officer in charge of the camp had interviewed the principal *zamindárs*; Mr. Cornish, the Collector, was ever ready to assist, and his influence was beneficially exercised. The section has very creditably finished everything in connection with the records of the present and past seasons, inclusive of arrears of the work of about 1,000 square miles. The field books will now be submitted for record, the traverse tables being retained for proving offsets and for reference generally.

410. The cadastral sections, under Messrs. R. C. Ewing and S. O. Madras respectively, commenced work on 1st December 1892 and closed the field survey and the record writing by 10th June 1893, although the latter was continued in some places till the end of the month.

The area cadastrally surveyed is in the Bhadrak circle, and the particulars are given in the following statement:—

District.	Cadastral survey, 16 inches=1 mile.		
	Number of villages.	Number of fields.	Area in square miles.
Balasore	2,057	1,437,117	1,093

411. The average size of the field is 0·49 of an acre. The record-writing of all but 12 villages, having an area of about 15 square miles, was completed. It consisted of 1,419,258 fields. Chandbally, on the Baiturni river, which is the calling station of the Calcutta steamers, Bhadrak town, and 269 other village sites, were surveyed on the 32-inch scale to permit of the record-writing of agriculturists' homesteads.

412. The demarcation of the tract under survey, which was effected the previous season, was found to have become so defective that the camp officers were obliged to renew it, by exercising the powers with which they are invested under the Survey Act.

413 The records of 1,728 villages were submitted to the Settlement Department for final attestation. Of these, 82 only were received back in the survey office, 79 of which have been finally completed and re submitted: three are in hand pending references to the Settlement Department.

414. The disputes on village boundaries numbered 617. Of these, 380 were settled and received back in the survey office for corresponding adjustment of the original records: there remain 237 still to be settled. A few of the disputes are between this district and the Keonjhar State of the Tributary Mahals, and can only be settled by the Superintendent of the Tributary Mahals.

415 The detail survey was checked by 3,919 linear miles of test survey, of which 1,214 miles were independent checks, being run after the maps had been lodged in office, and 2,705 linear miles were done by the inspectors in the course of the survey to test its correctness from time to time. The average amount of independent check survey is 1·11 linear miles per square mile of survey, and, if the inspectors' checks be added, it averages 3·5 linear miles.

416 The record of rights was checked by the examination of 432,671 *khasra* entries by officers and inspectors, the average being 30 per cent. on the outturn. Care was taken to separate *tahsil alahidá* lands, as far as they could be ascertained: the *amins* are dependent on information supplied by the *zamindárs*, for there is no other guide.

417. Copies of the Collectors' proprietary registers and statements of *lakhiraj bahal* and *baziaft minha nij-jot, nij-chas*, etc., were supplied by the Settlement Officer as a rule. The *lakhiraj*, etc., statements were used as guides to regulate claims for similar status at the current settlement. Sometimes these old statements were not forthcoming, and then they were merely compiled from the *khasras* as written.

418. The hill ranges of the Tributary States throw out low spurs into the area cadastrally surveyed, which are continued here and there in isolated hills: these hills and spurs were approximately contoured on the large scale on the original plans.

419. The circle officer, Mr. T. L. Maddox, C.S., and Babu Chaku Lal Sarkar were solely engaged on checking *khanapuri* from December 1892 to 31st March 1893. On 1st April the final attestation of the records was commenced, these officers being reinforced by Babu Prosunno Bannerjee, and after that date only one officer checked the *khanapuri*. The new amalgamated procedure had fair play in the Bhadrak circle, the division of labour being adjusted so as to enable the officials of both the Departments of Survey and Settlement to fully co-operate with each other.

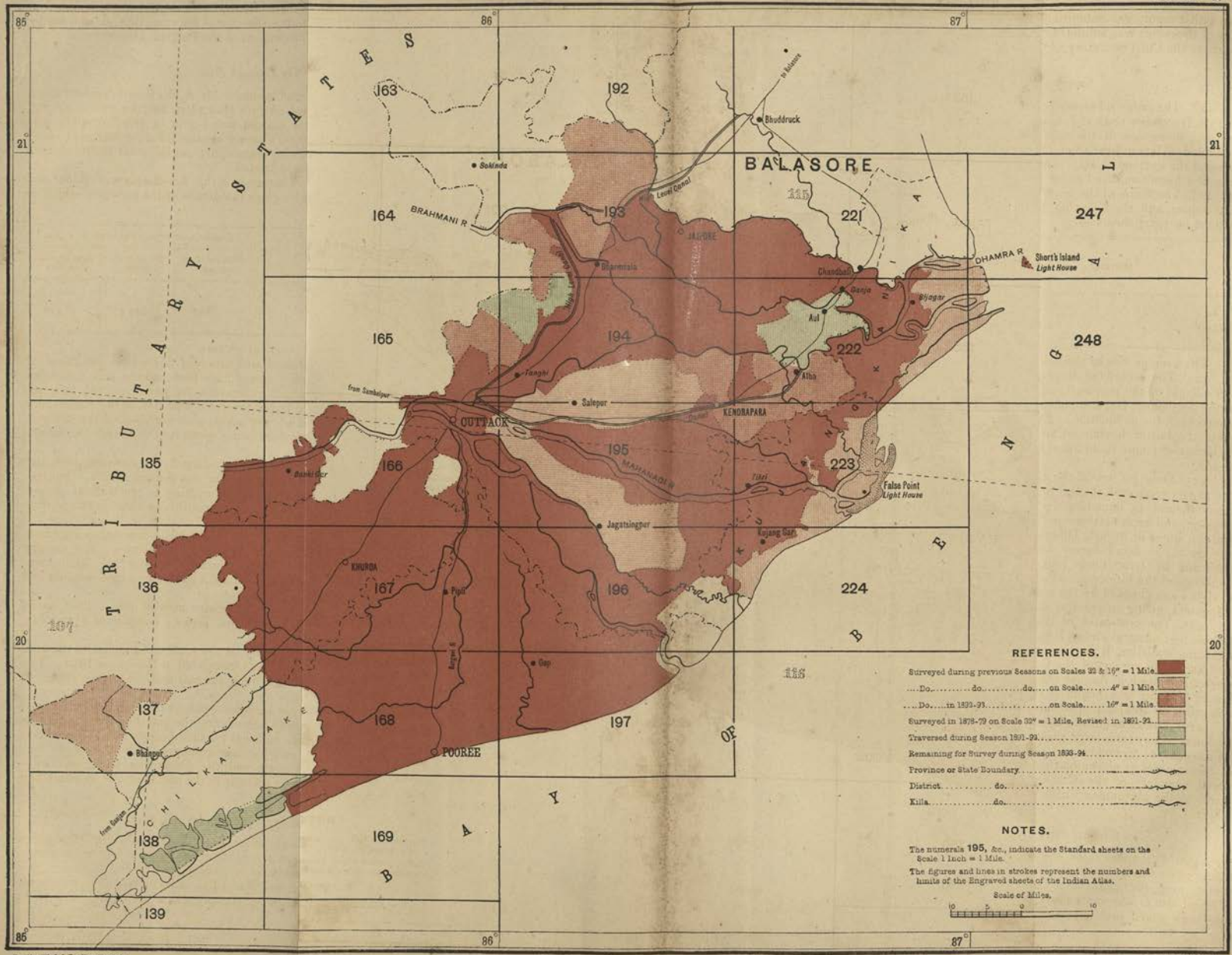
420. The cost-rates per square mile in this district are—for the cadastral survey R68-8, for *khanapuri* R13-5, for completion of records, including statistics, R21-1.

421. In consequence of a recent land dispute between a *zamindár* of the British Government and the lessee of the French possessions in Purana Balasore, and the subsequent arrest of the former on disputed ground, the Collector of Balasore requested that a survey should be undertaken of the boundary in dispute; consequently it was made by Mr. J. P. Barker, Sub-Assistant Superintendent, and recorded in a field book, a French officer being permitted to take a copy of the field book. The demarcation being done under the orders of Mr. Cornish, the Collector, the plan was first made on the 4-inch scale, and on it was shown by transfer the possessions of the French according to the 4-inch professional survey maps of 1841; but as the scale did not clearly show the several lines of possession and the claims, a map on the 16-inch scale was subsequently projected by orders of the Commissioner of the Orissa Division. A tracing of this

ORISSA SURVEY.

INDEX TO THE CADASTRAL SURVEY OF ORISSA, DISTRICTS CUTTACK & POOREE.

No. 8 PARTY.



REFERENCES.

Surveyed during previous Seasons on Scales 32 & 16" = 1 Mile.

....Do.....do.....do.....on Scale.....4" = 1 Mile.

....Do.....in 1893-93.....on Scale.....16" = 1 Mile.

Surveyed in 1878-79 on Scale 32" = 1 Mile, Revised in 1891-92.

Traversed during Season 1891-92.

Remaining for Survey during Season 1893-94.

Province or State Boundary.

District.....do.....

Killa.....do.....

NOTES.

The numerals **195**, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

10 5 0 10

Reg. No. 379, S. I. D.—Nov. 93—2,375

Photo., S. I. O., Calcutta.

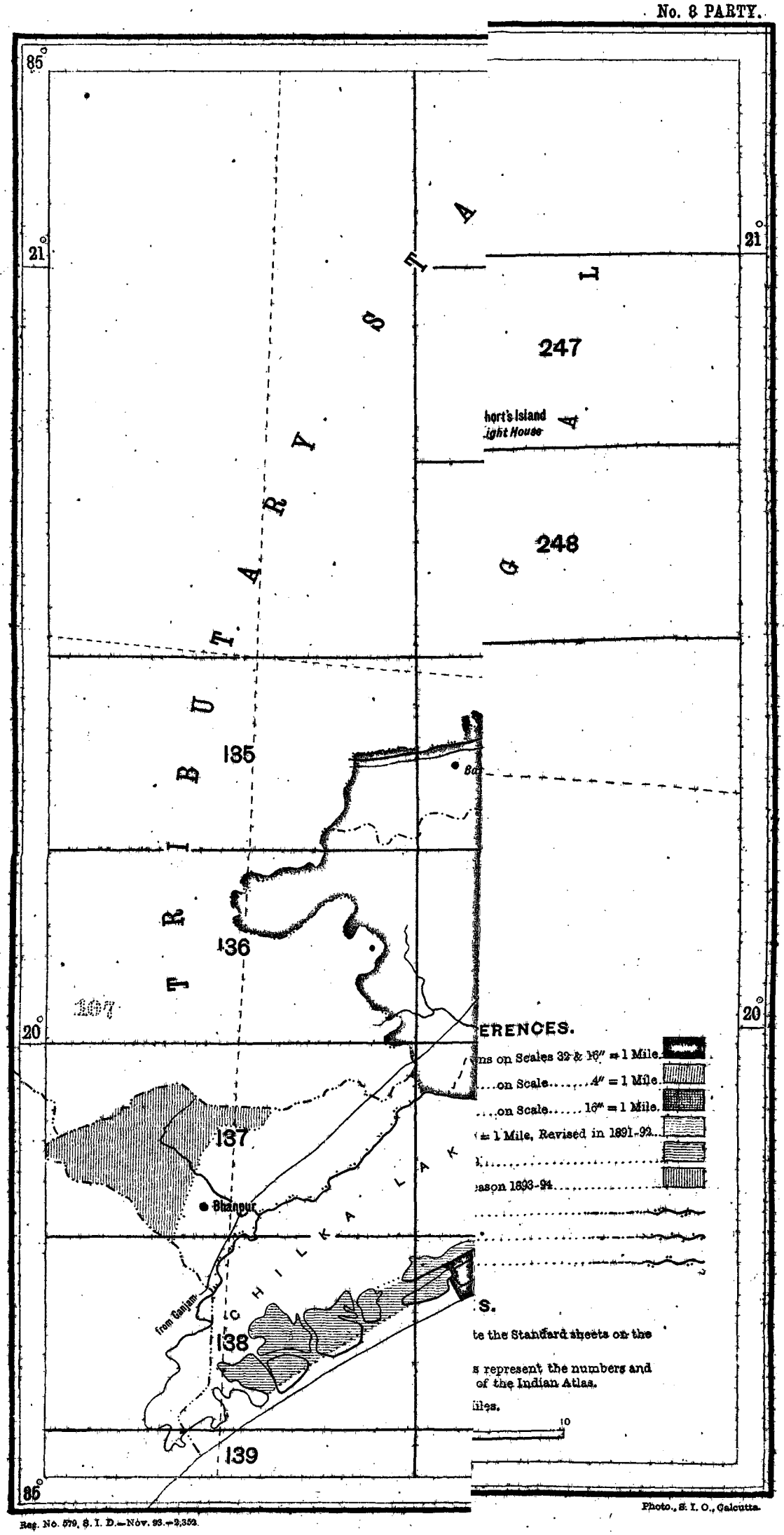


Photo., S. I. O., Calcutta.

Reg. No. 579, S. I. D.—Nov. 93.—2,352.

map with a report was submitted to that officer, and a duplicate tracing and a copy of the report was submitted to the Director of Surveys, Bengal, who made it over to the Chief Secretary to Government in the Political Department.

Survey of the Cuttack District.

422. The cadastral survey operations under Mr. A. W. Smart were resumed on 13th December 1892 and closed on 13th May 1893, but the record-writing, inclusive of arrears of the former season, was begun in October 1892 and continued till late in June 1893, the work having been retarded by the floods which followed the cyclone of May. All the temporarily settled areas in the district have now been completed as far as is known.

423. The *locale* of the season's survey is in the sub-divisions of Jajpur and Kendrapara, and the following table gives the details of the out-turn, which is mapped on 1,007 sheets :—

District.	Cadastal Survey, 16 inches = 1 mile.		
	Number of villages.	Number of fields.	Area in square miles.
Cuttack	862	622,461	470

The average size of the field is 0·5 of an acre.

424. The records of the cadastral area surveyed this season and those of 251 villages of the previous season's survey have been written and submitted to the Settlement Department for final attestation, but none have yet been received back for completion. The Jajpur town and a portion of the Kendrapara town, the lattter having an area of 305 acres, were surveyed on the scale of 64 inches = 1 mile to admit of numbers being given to the houses and homesteads.

425. Only 76 out of the 138 village boundary disputes were settled, and the papers connected therewith received back in the Survey Office. The remainder, and 15 boundary dispute maps appertaining to the work of season 1891-92, still await settlement. Some of these are disputes between the district and the states of Atgarh, Dhenkanal, etc., of the Tributary Mahals.

426. The detail survey was checked by 985 linear miles of independent lines and by 1,207 linear miles, which were run by inspectors. The average incidence of the former per square mile is 2·1 and of the latter 2·5. The record of rights was checked by the examination of 296,129 numbers by assistants and inspectors, giving an average of 31·5 per cent.

427. The cost-rates of the work per square mile in this district are as follows :—Cadastral survey, ₹65·7 ; *khanapuri*, ₹46·1 ; completion of records, including statistics, ₹38·5.

428. The survey of the Cuttack city on the scale of 64 inches to the mile was commenced in August 1892, and was completed in November 1892. The record of rights was begun in October 1892 and was finished in July 1893. It comprises an area of 4 square miles.

429. The cantonments have not been surveyed, as the military authorities declined to pay for a large scale map, considering the one they already possess on the scale of 36 inches = 1 mile sufficient for their purposes. The boundary of cantonments as shown on this map has been compared with the recently surveyed boundary of the Cuttack town, and the differences (due to encroachments on the cantonment) have been brought to the notice of the commanding officer.

General remarks applicable to both districts.

430. The agency for the survey consisted almost solely of Hindustani *amins* : the cost of survey has been somewhat raised by the inferior workmen which were obtained. The Director is of opinion that the introduction of this element into Orissa was a mistake, and that if Uriyas had been solely employed, the work would probably have been as cheaply and as well done. But to do

this would have involved considerable foresight and trouble in the recruiting of sufficient establishments to meet the increases sanctioned in 1891. The Uriyas have of necessity been employed on the record of rights (*khanapuri*). The records were prepared in accordance with the general principles of procedure which were discussed on the 2nd and 3rd November 1892 between the Directors of Land Records and Surveys, the Settlement Officer of Orissa, and the Deputy Superintendent of Survey in Orissa, and amended rules drawn up.

431. The principles consist in—

(*a*) joint control of Survey and Settlement Officer;
(*b*) the completion of the records, including rents and status in the first instance, with the exception of the Settlement Officer's personal entries;
(*c*) the responsibility of the Survey Officer for the maps and of the Settlement Officer for the records;
(*d*) the simultaneous *khanapuri* of the three records, *viz.*, *khasra*, *khatian* and *parcha*;
(*e*) the revision of the *khewat*, the proprietor's register.

These principles were sanctioned by the Board.

432. The *khanapuri* has been systematically tested by the circle and sub-circle officers, assisted by the officers of the Survey Department, when the latter could be spared from actual survey work.

433. The Settlement Officer of Orissa describes the new system in the following words:—

> The object of the new system was to have the *khanapuri* so supervised at the time that it is being done by the Assistant Settlement Officers, that the records will be sufficiently correct to enable final attestation to be done at once from them without the necessity of sending irresponsible, ignorant and untrustworthy *muharrirs* into each village before final attestation to correct errors preliminarily and to settle as many disputes as possible.....it may confidently be anticipated that the system has done much good by correcting broad errors made by *amins* and inspectors.

434. A training school for the 50 *patwáris* of the Balasore district was started on 1st September at Balasore town. When field work is resumed these men will be employed, so that they may be fitted to form the nucleus of the permanent staff which will be required for the maintenance of the records.

435. As the mapping of 2-inch standard sheets had fallen considerably into arrears, in consequence of the large areas which have been surveyed during the two past seasons, a special mapping section was formed during the recess, which has resulted in considerable progress being made. The mapping will in future proceed uninterruptedly, being transferred to the Director's Drawing Office in Calcutta, whenever the opportunity offers. There are 67 sections in all, $7\frac{1}{2}'$ in latitude and $15'$ in longitude, the graticules of all of which have been projected; 42 sheets have been plotted, 35 pentagraphed and 33 typed and drawn. Thirteen have been finished and 4 examined, and will now be submitted for publication.

436. The Settlement Officer of Orissa expresses himself in the following words regarding Lieutenant Crichton:—

> I desire to express my regret at having since the close of it (the year) lost the co-operation of Lieutenant R. Crichton, who was in charge of the Survey party up to the end of April 1893. His thorough acquaintance with details, and constant appreciation of the necessity of the Survey and Settlement Departments working as one, made my introduction to the work a particularly pleasant one.

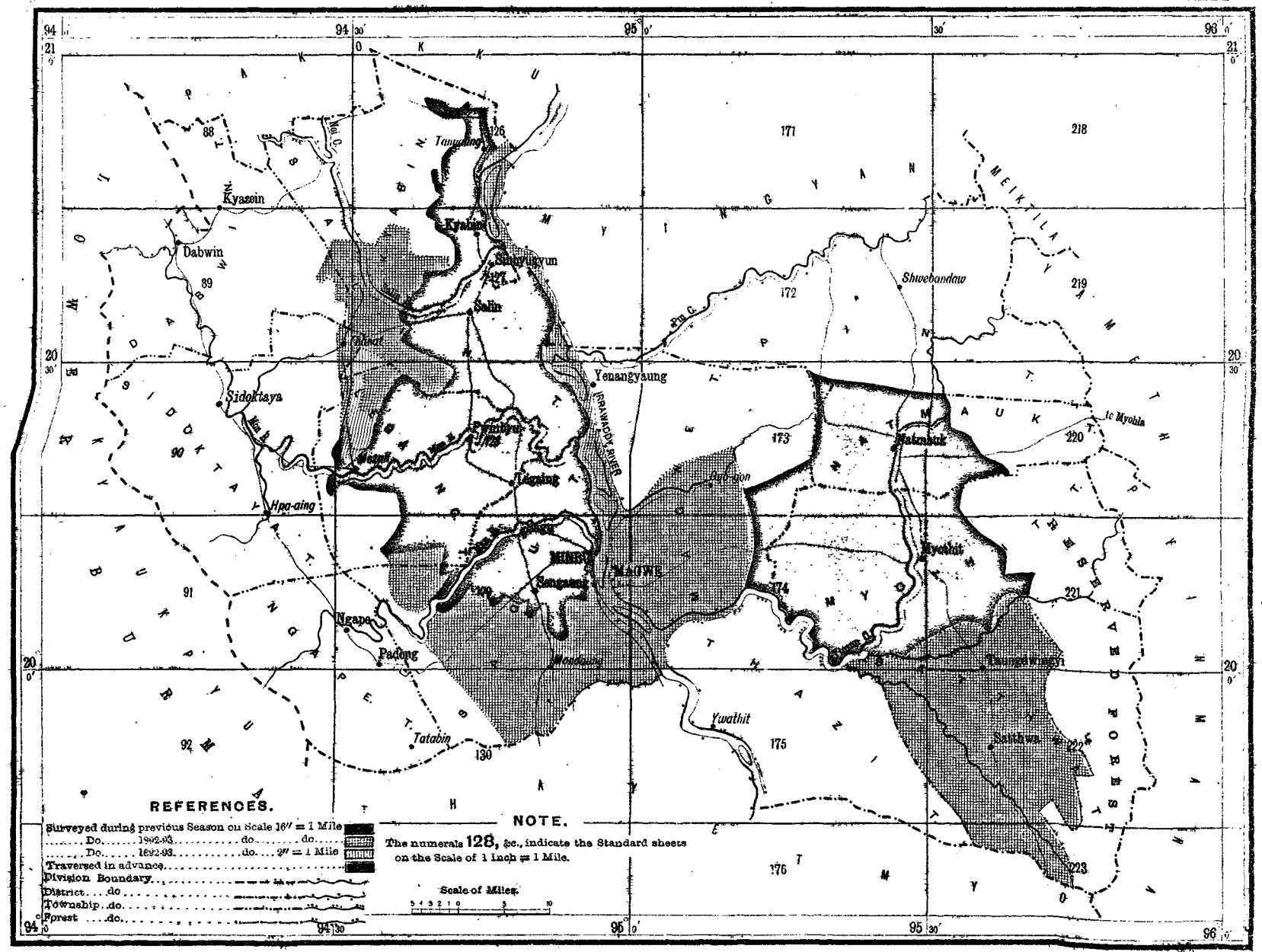
The Director of Surveys endorses the regret which is thus expressed, and reports that Mr. R. C. Ewing, who has held charge of the survey since May 1893 to the close of the season, has been animated with the same spirit and has co-operated in full with the Settlement Officer. With one exception all the assistants have worked well. Mr. A. W. Smart has done especially well, and Mr. C. S. Kraal also deserves credit.

437. The revenue officers of the division have aided the Survey officers on all occasions; more particularly is Mr. Maude's attitude of friendliness gratefully acknowledged by the executive officers. Mr. Cornish, the Collector of Balasore, also rendered substantial aid.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICTS MINBU & MAGWE.

No. 12 PARTY.



REFERENCES.

Surveyed during previous Season on Scale 16" = 1 Mile
Do. 1892-93 do. do.
Do. 1892-93 do. 2" = 1 Mile
Traversed in advance
Division Boundary
District ...do
Township ...do
Forest ...do

NOTE.

The numerals **128**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

Scale of Miles.

5 4 3 2 1 0 5 10

Reg. No 670, S. I. D.—Jan. 94.—550.

Photo., S. I. O., Calcutta.

No. 223-S. 94.

Survey of the Jaggarnath Temple Lands, District Puri.

438. With reference to the Bengal Government Notification, dated 5th March 1892, directing a survey to be made and a record of rights prepared in respect of all lands in certain *mauzas*, in certain revenue-free estates belonging to the temple of Jaggarnath in Puri, Lieutenant Crichton was directed to carry out test surveys of the maps thereof made in 1876 to ascertain how it will be best to proceed. A revision survey was therefore made of 17 villages, covering an area of 10 square miles, and an estimate based on the results for completing the revision survey with record of rights of these lands, has been forwarded to the civil authorities.

MINBU AND MAGWE DISTRICTS, UPPER BURMA.

No. 12 Party.

439. Field operations were resumed in the Minbu and Magwe districts about the 23rd November 1892, and closed on the 22nd June 1893, when the party returned to recess quarters in Mandalay. Three sub-surveyors were kept out during the rainy season to carry on advance traverse survey, the rainfall in the two districts not being sufficiently heavy to seriously interfere with such out-door work. The strength of the party is given in the margin.

Personnel:

Mr. W. H. Patterson, Deputy Superintendent, 1st grade, in charge up to 23rd September 1893.
„ A. E. Spring, Assistant Superintendent, 1st grade, in charge from 24th September 1893.
„ W. S. Buttress, Extra Assistant Superintendent, 2nd grade.
„ E. G. Little, Extra Assistant Superintendent, 3rd grade.
„ J. S. Swiney, Extra Assistant Superintendent, 6th grade.
„ A. George, Sub-Assistant Superintendent, 1st grade, from 6th November 1892.
„ W. E. Johnson, Sub-Assistant Superintendent, 1st grade.
„ F. S. Bell, Sub-Assistant Superintendent, 2nd grade.
„ H. W. Biggie, Sub-Assistant Superintendent, 3rd grade, from 13th June 1893.
28 sub-surveyors and others.

Temporary Establishment.

72 inspectors, draftsmen, and computers.
95 field surveyors (Indian).
53 field surveyors (Burman).

440. The programme of work of this party consisted of—

(*a*) the traverse survey of 28 square miles, and the cadastral survey of 500 square miles, in the Minbu district.

(*b*) the traverse and cadastral survey of a portion of the Magwe district.

(*c*) the advance traverse survey of 550 square miles in the Magwe district.

441. The demarcation was found to be well in advance of the survey, and rough township maps were furnished, showing the boundaries of *kwins* (villages) and circles. Wooden posts, round the bases of which stones or broken bricks were piled, were placed by the demarcation officer at salient points along the boundaries. Boundary disputes which could not be settled at the time of demarcation were referred to the Deputy Commissioner for disposal.

442. The work in district Minbu consisted of the cadastral survey of the flat cultivated portions of country lying south and west of the tract surveyed during the previous season. In the Magwe district the area traversed in advance last season was surveyed, and the traverse and cadastral surveys in the Taungdwingyi sub-division were commenced.

443. The out-turn of work in both districts, as well as a small portion in Myingyan district, arranged by townships, is given in the following table :—

Districts.	Townships.	Traverse Survey.			Cadastral Survey, 16 inches = 1 mile.		
		Number of villages (*kwins*).	Number of sub-traverses.	Area in square miles.	Number of villages (*kwins*).	Number of fields.	Area in square miles.
Minbu	Kyabin	2	103	5·8	16	13,849	45·5
	Segaing	...	2	...	9	4,505	64·3
	Sagu	8	12	9·6	32	20,240	267·6
	Salin	12	17	14·1	30	29,145	90·8
	Sedoktaya	5	14	8·9	15	15,549	23·1
	Totals	27	148	38·4	102	83,288	491·3

Districts.	Townships.	Traverse Survey.			Cadastral Survey, 16 inches = 1 mile.		
		Number of villages (*kwins*).	Number of sub-traverses.	Area in square miles.	Number of villages (*kwins*).	Number of fields.	Area in square mile.
Magwe	Magwe	91	251	143·8	104	112,594	269·0
	Myothit	309	493	396·4	...	...	...
	Natmauk	112	250	131·5	...	...	...
	Pin	...	...	...	...	...	...
	Satthwa	218	573	468·3	218	371,080	469·5
	Thazzi	...	...	...	15	3,747	11·0
	Totals	730	1,567	1,140·0	337	487,421	749·5
Myingyan	Myingyan	...	...	...	5	4,510	11·8
	Grand Totals	757	1,715	1,178·4	444	575,219	1,252·6

The above areas include 25·44 square miles of hilly ground surveyed on the scale of 2 inches to the mile to complete the topography, as it was not considered advisable to leave small blanks within the limits of the tract brought under cadastral survey. The survey in the Magwe district takes in the irrigated areas of Satthwa, Myothit, and Natmauk townships; the local officials considered that these portions should be surveyed first, not only for assessment purposes but also to assist the Irrigation Department in framing their projects for improving and extending the system of irrigation. The detail survey in these irrigated tracts was very intricate, each small field being surrounded by a strip of waste land covered with thorny bush and jungle; progress in these parts was consequently slow.

444. The average size of the *kwin* or village is 1,806 acres and the average size of the field calculated on the whole area is 1·39 acre. Excluding uncultivated tracts, the average size of the field is about 0·47 acre in irrigated, and 3·08 acres in unirrigated tracts. Of the area surveyed, about 509 square miles are cultivated and 743 square miles uncultivated. All the principal streams and permanently-used village cart-roads in the uncultivated tracts were surveyed and mapped on the 16-inch sheets.

445. The number of linear miles traversed was 4,739; two chains were used throughout, to ensure accuracy in the chain measurements. The positions of 107 conspicuous objects, chiefly masonry pagodas, were fixed by triangulation from the traverse stations. The theodolite was set up at every station in the magnetic meridian; and hence the magnetic bearing of every line is given; this will be useful hereafter in obtaining a close approximation to the magnetic variation at each village at the time of survey; this method also assists in the discovery of any large errors due to incorrect readings.

446. Zinc or corrugated iron tubes, as described in paragraph 340 of last year's report, were again used for the permanent marking of Survey stations. A few stations of 1891-92 were examined and the tubes were found to be in good condition. In order to be able to form a better opinion of the durability of these zinc tubes, other Survey stations will be examined during the ensuing season in selected localities, more especially so in the irrigated tracts, and a further report will be given of the state in which they are found. The local officers, through the head-men of the villages, have had mounds of earth heaped over these permanently-marked stations, to ensure their protection. None of the Survey marks were disturbed by the villagers during either the present or the previous year, but some stations along the banks of the rivers were destroyed by heavy floods. The Deputy Superintendent of Survey has asked that the *thugyis* should note for future reference on the plots showing traverse stations which have been supplied to them, the particular Survey marks that have been lost or destroyed. In Minbu 2,258 and in Magwe 30,557 theodolite stations were

fixed, and, of these, 27,452 have been permanently marked. The remaining stations are situated in island villages, which are liable to be swept away during the monsoon months and which it would be useless to attempt to mark permanently. The average number of theodolite stations thus permanently marked in a square mile is 51 in Minbu and 22 in Magwe, and the cost per square mile is R3-15-6.

447. Under the Upper Burma Boundaries Act notices have been served on the *thugyis* for the preservation of the theodolite stations as well as of the boundary marks. Duplicate copies of these notices were made, and on each a 2-inch skeleton chart was prepared, showing all the theodolite stations and the connecting lines. One copy was retained by the *thugyis*, and the duplicate was made over to the Deputy Commissioner.

448. This year a larger staff of Burman field surveyors was employed, and of the area surveyed in detail 336 square miles were surveyed by Burmans, against 917 by men imported from India, the number employed being 53 and 95 respectively; of the local men only nine came from the districts under survey. There has been a marked increase in the out-turn of work done by the Burmans who have now worked three and four seasons in the Survey Department. The average monthly earnings of the Burman surveyors was R30-8-4, and that of the Indian surveyors was R38-13-11, whilst the highest amount earned by a Burman in one month was R44-8, as against R66 earned by an Indian surveyor. The work done by the Burmans in cultivated tracts is good. They, however, are not reliable workers in jungle tracts; they have not the endurance of the Indians, and it will not be possible to depend on the Burmans entirely as field surveyors if a large out-turn is required. A large staff of Burmans has been employed this recess to prepare traces and to compute field areas: the work done by them is satisfactory.

449. The field work was tested by check lines run by inspectors as the survey progressed, followed by test lines run by the European assistants as the sheets were completed. The test surveys proved the work in the cultivated tracts to be very good. Errors were discovered here and there in uncultivated tracts; the men found fault with were made to redo the bad work without further remuneration. The total length of test lines amounts to 2,462 miles, of which 1,112 miles were run either by Europeans or independently. The average of check work per square mile of survey is 1·11 linear mile for European and independent tests, and 0·92 for those by inspectors.

450. The season's 16-inch detail survey in Minbu is mapped on 484 sheets, and in Magwe on 871 sheets, making a total of 1,355 sheets. The inking in of the sheets is well advanced. Tracings and area statements of 85 villages in Minbu, covering an area of 393 square miles, the work for the current season, have been furnished to the Settlement Officer up to date, and also skeleton index maps on the scale of 2 miles to the inch, and rough angular plots on the scale of 2-inches to the mile. Tracings of the four sections on the 2-inch scale of standard sheet No. 127 have been prepared and despatched to this officer. No Settlement Officer has been appointed as yet to the Magwe district. The work of the tracings and the area statements is well advanced.

45.. The cost-rates per square mile for the different kinds of work are as follows:—Traverse survey, R57-3-0; permanent marks R3-15-6; detail survey, including supply of area statements and tracings, R127-14-1. The aggregate cost-rate per acre for all these operations amounts to $4\frac{3}{4}$ annas, which is a decrease of nearly $\frac{1}{2}$ an anna on the rate of the previous year.

452. Local menial labour was again utilised this year in both districts. The Burman field surveyors worked entirely with men obtained from the villages, whilst each Hindustani surveyor had two Burmans attached to his camp. There was no difficulty in getting men to take service as chainmen at the rate paid, *viz.* 4 annas per day to those who did not leave their villages, and 5 annas to those who took service for the season.

453. The establishment enjoyed good health, on the whole, during the field season. There was a certain amount of sickness at the beginning and the end of the field season. Eighteen deaths occurred from cholera and fever.

454. Every assistance was rendered by the villagers, and great harmony prevailed between the Indians and the Burmans. Mr. Hartnoll, the Deputy Commissioner of Minbu, and Mr. Eale and Captain Browning, Deputy

Commissioners of Magwe, as well as the Sub-divisional Officers of Sálin and Taungdwingyi, are to be thanked for the cordial aid rendered to the Survey party. The work was much facilitated by the ready co-operation of the above-mentioned officers. Two well-known dacoit leaders and their gangs repeatedly traversed the part of the Minbu district where survey operations were carried on: this caused some uneasiness to the small detached parties, but owing to the precautions taken by the local authorities, no one was molested.

455. The programme for the ensuing season is the completion of 1,228 square miles of traverse and 1,000 square miles of cadastral survey in the Magwe district. After completion of the traverse survey in the Magwe district, work will be commenced in Myingyan, which is immediately to the north of Magwe and contiguous to the work that will be taken up in the ensuing season.

456. During the field season, the Commissioner of the Southern Division and the Deputy Commissioners of Minbu and Magwe visited the Survey office at Minbu.

The Deputy Surveyor-General inspected the office at Mandalay on the 6th and 7th September 1893, and reports that he found everything in good order. He subsequently visited Minbu and had an interview with the Commissioner of the division, when the general progress of the survey was discussed, and the suitability of Minbu as a place at which the party might recess was enquired into. It was then decided that for several reasons it would be much better to keep the party at Mandalay and not move it to Minbu.

457. Mr. W. H. Patterson, Deputy Superintendent, 1st grade, retired from the service on the 23rd September 1893.*

GARHWAL DISTRICT, NORTH-WESTERN PROVINCES.

DETACHMENT.

458. The strength of this detachment, which continued the cadastral survey of Garhwal, is shown in the margin. The number of imported field surveyors employed this year was 64, as against 112 during 1891-92. The out-break of cholera during 1891-92, and the inconveniences and difficulties the men had to contend against in consequence of the failure of the winter crops, created such a scare amongst the old staff that many of them sought employment elsewhere. No serious disadvantages resulted therefrom, as the majority of local *amins*, who have been employed during the two previous seasons, are now as efficient as most of those imported from the plains, and a sufficient number of apprentices were forthcoming to take the place of the men who had not rejoined. The only drawbacks to the employment of hill surveyors are, that they are not so neat and clean in their work as the men from the plains, and that as their homes are conveniently close, they frequently absent themselves from their work.

Personnel.

Mr. T. F. Freeman, Extra Assistant Superintendent, 6th grade, in charge.
„ W. Skilling, Sub-Assistant Superintendent, 2nd grade.
„ J. H. Murphy, Sub-Assistant Superintendent, 2nd grade.
7 sub-surveyors, computers, etc.

Temporary Establishment.

18 inspectors.
64 field surveyors (Hindustani).
203 field surveyors (local).
196 draftsmen, estimators and *muharrirs*.

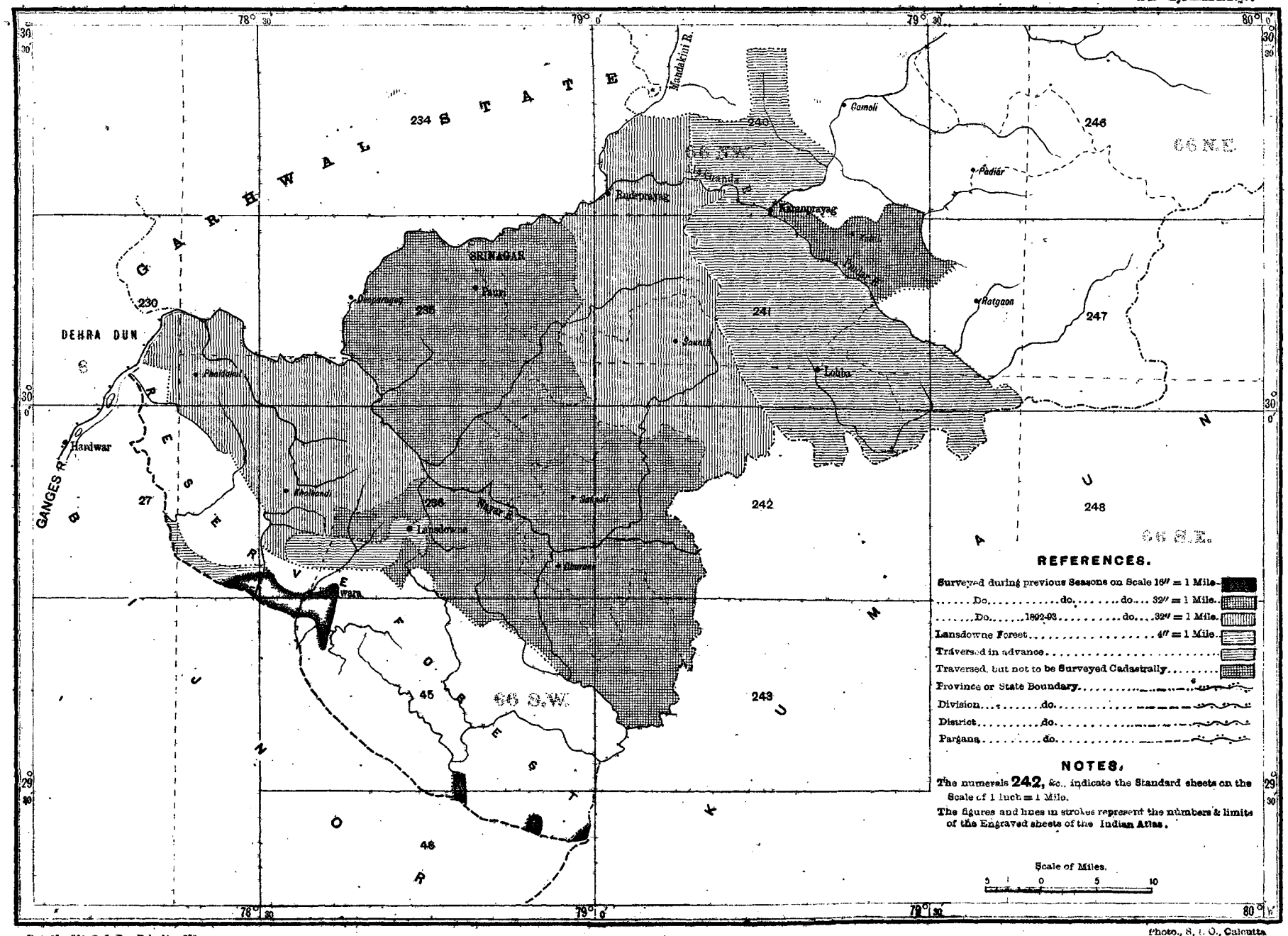
459. Field operations were resumed on the 25th October 1892. Owing to the scattered nature of the work remaining to complete the more accessible portions of the district, which alone were to be surveyed cadastrally, a recommendation was made to include certain of the intervening *pattis*, and sanction was accorded to this in G. O. No. $\frac{405}{46}$, dated 22nd February 1893, in time to prevent the dispersion of the establishment over four different *parganas*. Operations were continued till the 10th June when, owing to the setting in of the rains, work was discontinued, and the drawing, estimating, traverse and part of the vernacular record sections proceeded to Naini Tal; whilst the other portion of the last-named section was located at Lobha.

* Mr. Patterson speaks well of the conduct of all the European assistants, but especially mentions Mr. Swiney for his good work. Of the native establishment he brings to notice the following:—Moti Lall, Laximan Kadekar, Abdul Wahid 1, Tufail Ahmed, Makbul Hussein, Vishnu Sitaram, Ghulam Hyder, Abdul Wahid 2, and Natu Khan.

N. W. PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT GARHWAL.

DETACHMENT.



Reg. No. 660, S. I. D.—Feb. 94.—550.

Photo., S. I. O., Calcutta.

No. 235-S. 94.

460. The system of traverse by the bar-subtense method, described in previous reports, was again adopted in the hilly tracts of Garhwal; but in the Bhabar, where accurate chaining was practicable, the ordinary procedure was followed. In Garhwal the traverses generally emanate from and close on trigonometrical stations of the Garhwal triangulation, thereby furnishing the necessary azimuths and rectangular co-ordinates for closing the work. In the Bhabar additional connections were made with trigonometrical stations. In 1889-90 it had been found impossible to connect some of the outlying villages with each other or with trigonometrical stations, and the traverses in such places were based on magnetic bearings. These have now, after a great deal of labour in clearing rays through thick jungle, been properly connected, and the computations have been revised.

461. All theodolite stations, both in Garhwal and in the Bhabar, have been permanently marked by triangles cut on rocks *in situ*, or on rough unhewn stones embedded in the ground and covered over with mounds of loose stones or earth. Receipts have been taken from the village *padhans* for the same.

462. The season's out-turn of traverse work consists of 34 square miles of supplementary traverses run in *parganas* Ganga Salan and Chandpur, 6·5 square miles in the Bhabar, and the revision of ninety-six traverses of previous season's surveys, which had proved incorrect. The supplementary traverses were run in order to include several detached blocks of cultivation, lying within the forest reserves to the south and west of *pargana* Ganga Salan, which had been omitted owing to a doubt as to whether the blocks referred to were included in forest area or not. Observations were taken at 965 stations, and the number of linear miles of chaining aggregated 161·5 miles. The traverses emanated from and closed on thirteen Great Trigonometrical Survey stations.

463. The cost of the season's out-turn in traversing amounts to ₹3,251. Of this amount ₹1,238 were spent on the 34 square miles of supplementary surveys run in Garhwal, and ₹183 on the area traversed in the Bhabar, thus giving rates of ₹36-6 and ₹28-4 per square mile, respectively, for the two localities. The balance, ₹1,830, was incurred on revisions of traverses run in seasons 1889-92.

464. The portion cadastrally surveyed in Garhwal, which is on the 32-inch scale owing to the exceptionally small size of the fields, embraces the whole of *pargana* Ganga Salan, the remaining three *pattis* of *pargana* Dewalgarh (which was partly surveyed in 1890-91), five *pattis* of *pargana* Chandpur, and one of Nagpur; besides the eleven villages of Talla Salan, which were left incomplete last season, owing to an outbreak of cholera. In addition to this, the whole of the area surveyed in the Garhwal-Bhabar in 1889-90 on the scale of 16 inches to the mile was revised, and the maps brought up to date, in accordance with instructions conveyed in North-Western Province's G. O. No. $\frac{482}{1-597\,(A)}$, dated 24th February 1893. In thirteen villages, the changes owing to extensions in cultivation and alterations in field boundaries were so great that they had to be re-surveyed entirely.

465. The details of the season's out-turn are given in the following table:—

Parganas.		Cadastral Survey.			
		Number of *pattis*.	Number of villages.	Number of fields.	Area in square miles.
Ganga Salan Dewalgarh Chandpur Nagpur	*Scale.* 32 inches = 1 mile	18	1,194	794,623	269·97
Bhabar	16 inches = 1 mile	...	61	3,928	18·27

466. Out of the 270 square miles surveyed in Garhwal it is estimated that 165⅓ square miles will be classified as assessable land, whilst at the time of last settlement only 56 square miles were assessed. The remainder of the area consists of small patches of intervening waste, roads, streams and village sites. The average size of the field calculated on the total area surveyed is 0·217 of

an acre in Garhwal and 2·98 acres in the Bhabar; on Garhwal it is 0·129 of an acre, but in some places the fields are as small as 0·01 of an acre: in such cases even the 32-inch scale is too small to allow of the numbers being clearly shown, and enlarged indexes have to be made on the margin of the map for the sake of legibility. Though the average size of the field exceeds that of previous seasons, still the cultivation is more detached and less suitable for chain measurements than in the *parganas* previously surveyed. The positions of scattered blocks of cultivation were chiefly determined by intersections with the sight rule, as the dense jungle and steep cliffs intervening between the different blocks rendered chaining not only more expensive but less reliable.

467. The cost of the detail survey and record writing of the area surveyed this season in Garhwal amounts to Rs. 46,930, giving a rate of Rs. 173-12 per square mile, as against Rs. 182-11 per square mile during 1891-92. This reduction in the rate is mainly attributable to the increased efficiency of the local *amins* and the smaller number of plains men employed; the latter received somewhat higher rates than the local men to compensate them for the travelling expenses they incur from and to their homes and for the inconveniences and privations they have to submit to in a country and climate so different from their own.

468. There were 499 boundary disputes in the season's work which were referred to the Settlement Department for decision. The Deputy Collector entrusted with the settlement of these disputes, having other district work to attend to as well, had only decided 305 of these cases up to the 1st October 1893, leaving 194 still undecided; thereby rendering it impossible to finally complete the maps and records of 388 villages.

469. In last year's report reference was made to the imperfect manner in which the boundaries of the Lansdowne Forest Reserve were demarcated. Several isolated blocks of village cultivation lying within the reserve were supposed to be demarcated by masonry pillars. It was found, however, that in some cases straight lines drawn between these pillars passed through these blocks, thereby throwing portions of the cultivated areas within the Forest reserve boundary. The vague descriptive list of boundaries and rough sketch map supplied by the Forest Department afforded very little assistance in interpreting the intentions of the Forest Settlement Commissioner. This necessitated a reference to the Commissioner of the Division, who in turn referred the matter to the Local Government. On the 6th February 1893 orders were issued directing that the existing demarcation should be upheld and, except where it was stated that the boundaries skirted cultivation or where it was obvious that natural features, such as streams, roads, etc., were intended for the boundaries, straight lines were to be drawn from pillar to pillar, the villagers receiving annual permission from the Forest Department to continue cultivating all fields or portions of fields which fell within the area of the Forest Reserve.

470. The unit of measurement is the field as defined by the Board of Revenue in its "Directions to Settlement Officers." All minor sub-divisions, such as terraces in fields, have been approximately shown in their respective positions by faint dotted lines. A deduction is made from the area of each field on account of these terraces which are supposed to be of an average width of 5 links; the number of each field is recorded in the column of Remarks in the *khasra*, as a guide to the estimator when calculating the amount of the deduction. This deduction averages 3·7 per cent. on the entire area surveyed, and 6 per cent. on the assessable area, which is a very liberal allowance considering fields are usually cultivated to within 2 to 3 links of the edges of the terrace walls. As in the *parganas* previously surveyed, small slabs of stones 6 to 9 inches long were embedded in the middle of fields to mark the limits of partitions made. These marks, called *odas*, are frequently removed in the interval between the completion of the survey and commencement of *khanapuri*; this necessitates frequent erasures in the original maps which are very objectionable, but unavoidable.

471. The procedure in preparing the record-of-rights adopted last season was again followed with two exceptions—

(i) Last season the *khatauni slips* or *parchas*, which were distributed to cultivators at time of *khanapuri*, were collected again a month after, for entry of the field areas and final completion, prior to re-

distribution at time of attestation. The majority of the *parchas*, however, were returned to the survey office in such a dirty condition that it was necessary to recopy them before they could be sent to the Settlement Department as a record; the Senior Member of the Board therefore directed that the *parchas* should not be collected again after they were once distributed, but that the field areas should be recorded on them at time of attestation if necessary.

(2) The other modification was as regards rights of cultivators to land, which had been cleared and cultivated by them continuously for a period of 12 years and over. Hitherto a tenant could not claim rights of occupancy to reclaimed land, unless he had been an occupancy tenant in the village at the time he extended his cultivation, or acquired such rights by purchase. Now the Commissioner has ruled that rights of occupancy may be acquired in newly cultivated land by continuous possession of 12 years and over.

Only hill *amins* were employed in writing up the *khanapuri*.

472. No alterations were made in the classifications of soils; those adopted last season being adhered to. Greater precautious were taken to detect the concealment of irrigated lands, which had been practised last season by the villagers who destroyed the irrigation channels prior to the commencement of survey operations and persistently denied that the fields were ever irrigated. During the current season, when broken channels were discovered, the villages were visited a second time after the *khanapuri* had been checked and finally passed, when any such deceptions were detected and rectified. An instance occurred where a piece of land, which was declared to be and had actually been classed as old fallow (which is not subject to assessment) at time of survey last season, was found to be not only cultivated but irrigated during the current season. Fortunately the discovery was made before the records had been submitted to the Settlement Department for attestation and the survey officer was able to rectify the papers prior to submission.

473. The new work has been carefully checked by the European officers in the course of their inspections. The independent *partals* and check lines run by European assistants aggregate 706 linear miles, and those by inspectors 1,048 linear miles. This gives an average of 6·5 linear miles of check lines in every square mile surveyed. In 24 cases the survey proved unreliable and had to be resurveyed; otherwise the work was found to be good. In the revision work in the Bhabar, 24 linear miles of test lines were run. Of the *khasra* entries, 11,218 numbers were tested by European officers and 212,123 by the inspectors, giving an average of 28 per cent. of fields checked. As a rule the entries were found to be correct and greater precautions were taken in endeavouring to detect any attempts at the concealment of tenants' rights by the *zamindárs*.

474. The season's out-turn in Garhwal is mapped on 2,937 sheets on the 32-inch scale, and in the Bhabar on 58 sheets on the 16-inch scale.

475. The following are the records prepared for the Settlement Department:—(1) *khasra*, (2) dispute list, (3) *phant* or *khewat*, (4) *muntakhib*, (5) *khatauni* slips or *parchas*, (6) *milan khasra*, (7) crop statement, (8) statistical statements in English, (9) tracing in duplicate of the village map (on one the different classes of soils are coloured), (10) tracing in duplicate of an index map of each *patti* on the 4-inch scale showing cultivation, principal roads, streams and village boundaries, as a guide to the Settlement Officer when making his final tour of inspections. The preparation of the *jamabandi*, which is merely an abstract of the entries in the village *muntakhib*, was discontinued by order of the Senior Member of the Board; its further preparation being considered unnecessary. The *phant* or *khewat* has also been further modified to suit local requirements. Up to the 1st October 1893 the records of 1,465 villages of the previous season's work and 135 of the current season's were made over to the Settlement Department for attestation.

476. The season's out-turn, as it is, exceeds that of previous years, but it would undoubtedly have been greater still had it not been for the repeated interruptions to work caused by the excessive falls of rain and snow. There were four falls of snow during the season, which not only interfered with the progress of the field work, but interrupted communications with the field surveyors and European assistants. The severe cold resulting therefrom also prevented the

men from working more than 4 to 5 hours a day in the field. Another drawback was the scattered nature of the cultivation which necessitated extra traversing and long chain lines through blocks of jungle and yet only added a few acres to the total out-turn.

477. Owing to the failure of both the spring and autumn crops in the hills in 1892, and the difficulty anticipated by the district authorities in procuring supplies locally for the survey establishment, special arrangements had to be made for the importation from the plains of grain for the use of the office establishment; it was found that the detached field surveyors could be supplied without difficulty by the villagers. A special grant was sanctioned for the purchase of these supplies, and the Local Government, on the recommendation of the Commissioner of the Division, agreed to their being retailed at fixed rates regardless of actual cost; any loss incurred thereby being borne by Government. At the commencement of the field season the loss promised to be very high; but later on when the spring crops were cut in the plains, grain was imported at such favourable rates that the net loss was reduced to R236, a sum much below what was anticipated by the Commissioner.

478. The traverse, drawing, area and part of the vernacular records section recessed at Naini Tal, whilst the remainder of the office was left at Lobha; sufficient accommodation not being available for a European officer at that place, the small establishment, which was left there to complete the vernacular records, was placed under the supervision of Bishambar Sahai, Munsarim, who has discharged his duties satisfactorily.

479. The programme of operations for the coming field season will be the completion on the 32-inch scale of the remaining *pattis* of *pargana* Chandpur, *patti* Pindarwar of Badhan, and *patti* Bichla Nagpur of Nagpur; the estimated area of these is 143 square miles (probably less). In addition to this, 6½ square miles, traversed in advance during the current year in the Bhabar, will be surveyed in detail on the 16-inch scale. This will complete the entire work that is to be done in this district.

480. Additional roads and villages having been formed since the topographical surveys made in this district in 1865-67, the Deputy Commissioner recommends that the 1-inch standard maps should be revised and corrected to date as soon as survey operations are completed. The present survey operations being confined to cultivated tracts only, arrangements will be made if possible to complete the surveys of all newly formed roads which pass through forests and uncultivated lands during the coming field season, and thus render the maps more complete.

481. The officer in charge expresses his indebtedness to the district authorities for their cordial assistance on all occasions whenever it was necessary. Relations between the survey employés and villagers were also more cordial than during the previous seasons, and so complaints were not so numerous, and there was less occasion to trouble the district officials.

482. The Deputy Surveyor-General visited the Survey Office at Naini Tal in October 1893 and inspected the work of the previous season, and enquired into the arrangements made for carrying out the programme for 1893-94. He reports that he was thoroughly satisfied with all he saw.*

* The officer in charge reports that Messrs. W. Skilling and J. H. Murphy gave general satisfaction in the performance of their duties, and that, of the native establishment, Badri Parshad, Hari Singh, Waris Ali, Bishambar Sahai, and Kurban Ali are deserving of mention.

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DIST. BILASPUR.

No. 9 PARTY.

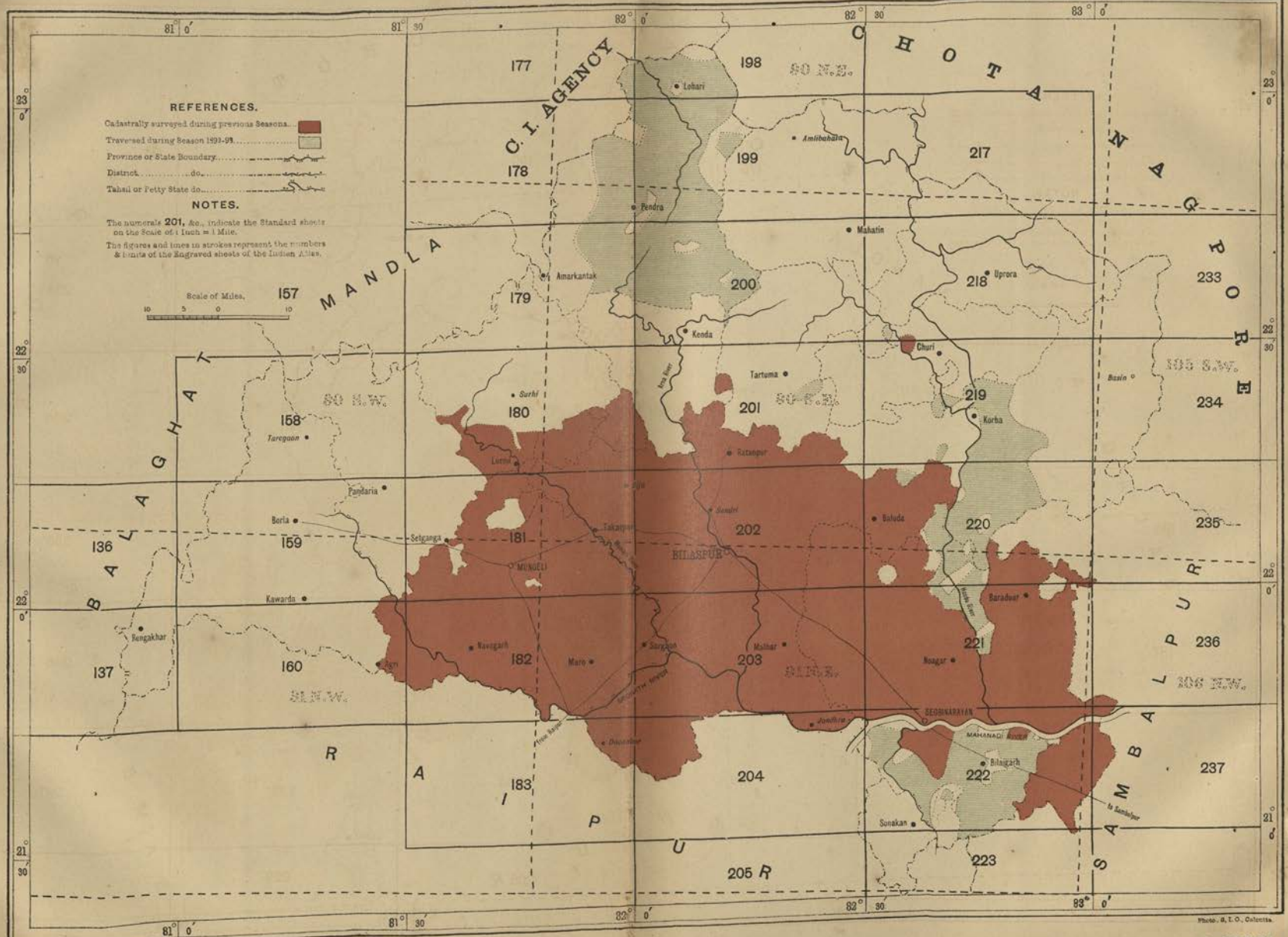


Photo. S. I. O., Calcutta.

No. 238-S. 94.

Reg. No. 676, S. I. D.—Feb. 96.—500.

TRAVERSE SURVEYS.

RAIPUR, BILASPUR, AND SAMBALPUR DISTRICTS, CENTRAL PROVINCES.

No. 9 Party.

483. This party, divided as before into three sections, has continued traverse operations in the Central Provinces, a certain number of villages in the *zamindári* estates of the Raipur, Bilaspur, and Sambalpur districts having been allotted to it for survey. There was in addition some revision work to be done in the Balaghat and Mandla districts, as well as the traverse of 116 villages in Balaghat, left unfinished from the previous season's programme.

Personnel.

Captain W. J. Bythell, R.E., Officiating Deputy Superintendent, 2nd grade, in charge up to 14th June and from 14th September 1893.
Mr. H. Dowman, Extra Assistant Superintendent, 3rd grade, in charge from 14th June to 13th September 1893.
„ A. George, Sub-Assistant Superintendent, 1st grade, up to 30th September 1892.
„ C. George, Sub-Assistant Superintendent, 1st grade, from 1st October 1892.
„ C. H. G. Johnson, Sub-Assistant Superintendent, 2nd grade.
„ G. Rae, Sub-Assistant Superintendent, 3rd grade.
42 surveyors, sub-surveyors, and others.

484. The detachments left recess quarters at Kamptee on the 15th of November 1892, camp No. 1, under Mr. C. George, resuming work in Balaghat and commencing that in Bilaspur, whilst camps Nos. 2 and 3, under Messrs. Dowman and Johnson, respectively, commenced operations in the Raipur and Sambalpur districts. Field work was closed on the 10th May 1893 by camps Nos. 2 and 3, and on the 31st May by camp No. 1, recess quarters being again established at Kamptee.

485. As in previous seasons, the object of the traverse survey has been to furnish the Settlement Department with skeleton plots of the village lands showing the traverse stations. These are marked on the ground by dressed stones, and afford the *patwáris* a large number of accurately fixed points on which to base the field-to-field survey. The traverse lines are run at a maximum distance from the demarcated village boundary lines of 3 chains, and in most instances are not one chain distant, especially in country where the line clearing is heavy. The village areas are further divided up into convenient sized blocks by sub-traverses, at a maximum distance of 30 chains apart.

486. The work this year presented considerable difficulty, owing to its extremely scattered nature, as will be seen from the index maps attached. A number of extra sub-circuits had to be run to connect the isolated patches of work; and much valuable time, too, was taken up in marching. Last year's report shows an area of 4,311 square miles, as against 2,316 square miles completed this season; but in the area returned in 1891-92 are 136 forest blocks, aggregating 1,196 square miles, which were merely traversed round, but of which plots were not required. In this year's report the actual area of plots only has been given, and these being in scattered blocks have really necessitated very nearly the same amount of labour as the larger area of 1891-92. The actual number of miles chained in the two seasons is nearly the same, *viz.*, 9,819 miles in 1891-92 and 9,431 in 1892-93. The cost-rate per square mile is of course equally affected by the small area, for though the total cost is nearly ₹1,000 less this year, the cost-rate is ₹34, as against ₹18 last year.

487. The traverse survey has been completed in the *zamindáris* of the Raipur district, but rather more than one-third in Bilaspur and one-half in Sambalpur of the total number of villages to be traversed remain for survey during the coming field season.

488. The following tabular statement shows in detail the out-turn of work for the season:—

Zamindari Estates in Districts.	Number of villages.	Number of sub-traverses.	Number of traverse stations.	Area in square miles.
Bilaspur	359	639	17,725	740
Raipur	525	1,022	24,827	879
Sambalpur	353	544	13,092	526
Balaghat	97	60	2,415	171
Total	1,334	2,265	58,059	2,316

489. Of the total number of traverse stations fixed, 49,655 have been marked by embedded dressed stones, about 2 feet in length, at a cost of 2 annas 10 pies each, or R3-14-10 per square mile. Two chains, one of 100 feet and one of 66 feet, were used by each surveyor throughout, and the angular measurements were checked by observations for azimuth at 432 stations. Connections were made with 13 stations of the Great Trigonometrical Survey to check the linear measurements.

490. No maps existed showing village boundaries, and the *mujmillis* supplied by the Settlement Department were inaccurate and practically useless. As a consequence, the surveyors were compelled to follow the demarcation as pointed out on the ground by village headmen. Skeleton maps on the 2-inch scale, showing all the villages traversed, were prepared as the work progressed, and tracings of these were supplied to the village headmen (*malguzárs*) concerned, to serve as guides to the relative positions of the embedded mark-stones, for the preservation of which they are held responsible.

491. On the whole, the demarcation was satisfactory in all four districts, and was kept in advance of the survey. The cases of boundary disputes were few and unimportant, and in no instance was the traverse work materially delayed thereby. In the Fingeswar *zamindári* of the Raipur district the demarcation included only the small isolated patches of cultivation comprised within each village boundary, and excluded all forest tracts. On the matter being referred to the Commissioner of Settlement and Agriculture, he directed that the demarcation should be upheld, with a view to avoiding a re-survey, though he was averse to the exclusion of forest lands from village areas.

492. A few cases were reported of the refusal of *zamindárs* to afford assistance to the surveyors in the matter of supplies, etc.; but in most cases a reference to the Deputy Commissioner of the district was sufficient to mend matters, and cordial relations were maintained throughout with the officers of the Settlement Department, and with the local authorities.

493. The country traversed this season, though varying considerably in the different districts, was, on the whole, free from hills, but generally clothed with dense jungle. The *zamindáris* of the Bilaspur district are nearly all located in the hilly area to the north, where the off-shoots of the Maikal Vindhya, and Korba ranges run down into the rich plains of Chhattisgarh. The *zamindáris* of Sambalpur, nineteen in number, are found considerably scattered, encircling the '*khalsa*' portion of the districts, and with the exception of Phuljar and Borasamar consist generally of undulating plains broken by isolated clumps of rugged hills. Only the eastern *zamindáris* of Raipur with Lohara, situated in the centre of the district, were allotted for survey. An extract from Captain Bythell's report on the country operated in will be found in the appendix.

494. The health of the party was generally good throughout the field season, though fever was prevalent, both at its commencement and close. There were six deaths—a considerable decrease on the number reported for the field season 1891-92. An abnormally heavy rainfall during the months of March and April considerably retarded the progress of the work.

495. During recess, all the computations in connection with the work of the past field season have been examined, completed and bound. Skeleton plots on the 16-inch scale, with area statements of 1,223 villages on 2,421 sheets, have been prepared and forwarded to the Settlement Department. The revising of the work in Mandla has been completed, and that in Balaghat, together with the new survey in that district, though it has progressed slowly owing to the sickness of the men employed thereon, will also be completed early in the ensuing field season.

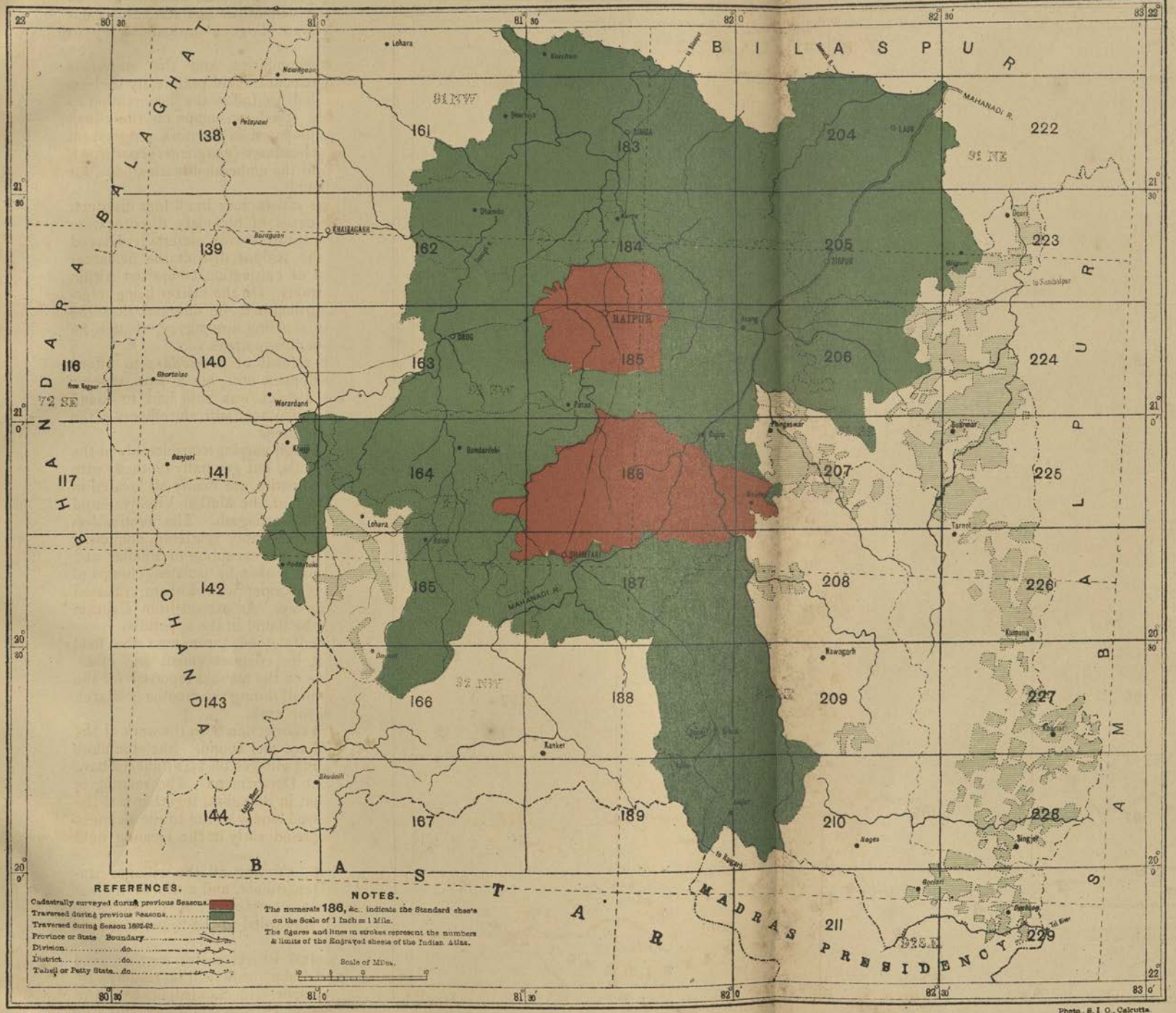
An index map of the Balaghat district, showing all the villages traversed, is in preparation for the Settlement Department, and a similar map of some of the Sambalpur *zamindáris* has been completed. A considerable quantity of traverse data has been copied and forwarded to the Superintendent of Forest Surveys during the year.

496. The retention of the party in the Central Provinces for another year having been sanctioned by the Government of India, work will be resumed by Camps Nos. 1 and 3 in districts Balaghat, Bilaspur and Sambalpur, and it is hoped that the entire programme will be completed, though a large amount still remains in the former district, where the ground is hilly, rugged and densely wooded. Camp No. 2 under Mr. H. Dowman will undertake the traverse survey of about 600 villages in the *zamindári* estates of district Chanda, and this work will probably be completed during the coming field season.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DIST. RAIPUR.

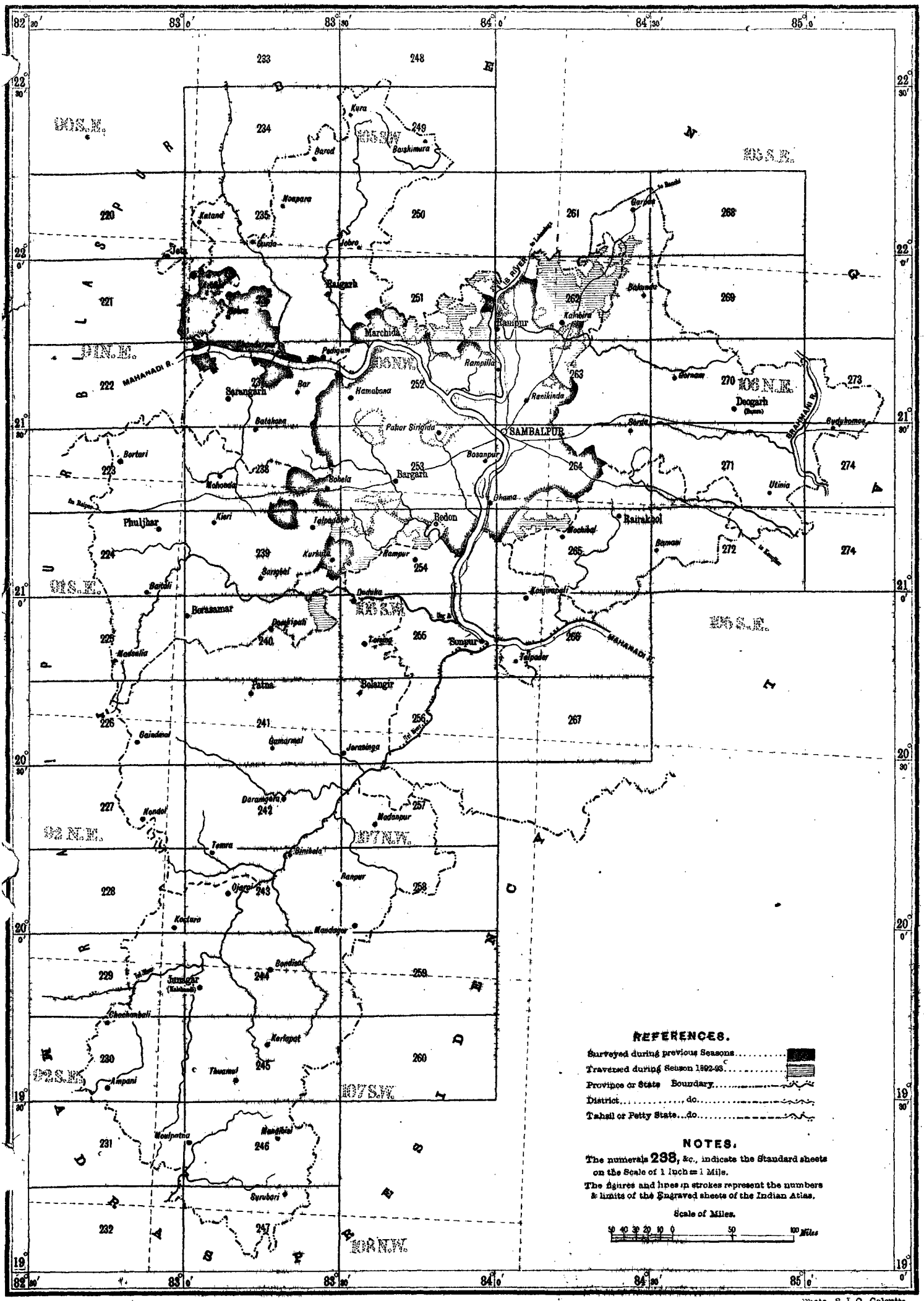
No. 9 PARTY.


BILASPUR
BALAGHAT
BHANDARA
WARDHA
BASTAR
MADRAS PRESIDENCY
RAIPUR
DRUG
KHAIRAGARH
MAHANADI R.
Lohara
Newargaon
Pelapani
Boraguon
Dhamda
Kurra
Ghortalao
Warardand
Fatao
Bandarchhi
Banjari
Khuji
Poddarbasa
Dongar
Kanker
Bhanupratappur
Kawardha
Kumhra
Tarnol
Dongargaon
Rajnandgaon
Chhuikhadan
Khairagarh
Dongargarh
Mungeli
Kota
Pendra
Gaurela
Marwahi
Sakti
Champa
Janjgir
Akaltara
Bilha

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT SAMBALPUR.

No. 9 PARTY.



REFERENCES.

Surveyed during previous Seasons.....

Traversed during Season 1892-93.....

Province or State Boundary.....

District.....do.....

Tahsil or Petty State...do.....

NOTES.

The numerals **238**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Scale of Miles.

50 40 30 20 10 0 50 100 Miles

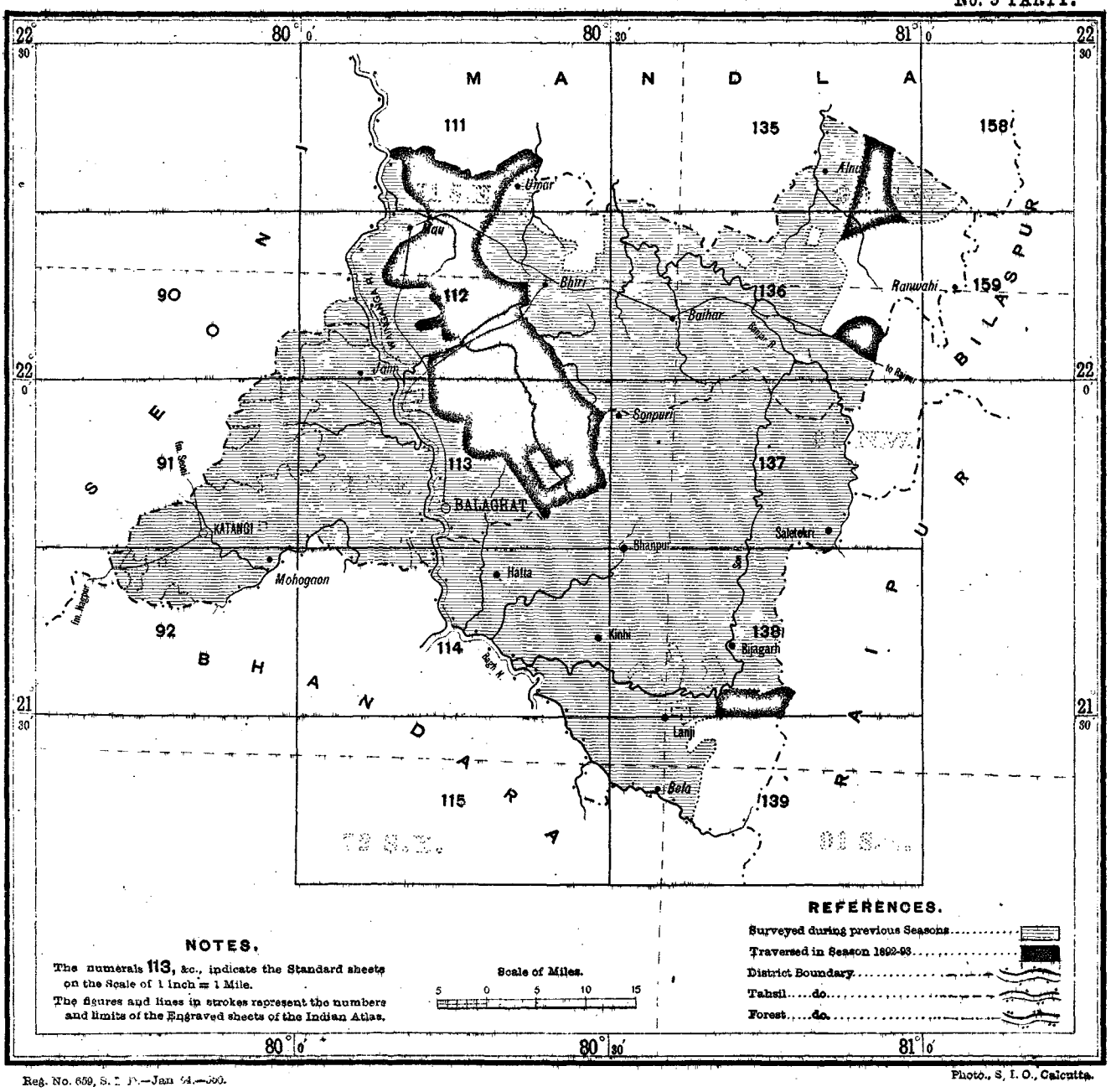
Reg. No 719, S. I. D.—Jan. '94.—550.

Photo., S, I. O., Calcutta.

No. 216-S. 94.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BALAGHAT. No. 9 PARTY.



Reg. No. 659, S. I. P.—Jan 94.—500.

Photo., S. I. O., Calcutta.

No. 218-S. 94.

497. The Deputy Surveyor-General in charge Revenue Branch inspected the recess office of the party at Kamptee on the 16th and 17th October, and reports that the work had been satisfactorily brought up. It was found that the number of lines requiring revision, in consequence of erroneous observations or incorrect chaining owing to carelessness on the part of the sub-surveyor, had been considerably reduced. This, no doubt, was in great measure due to the more favourable nature of the country, but orders were also issued that any revisions found necessary should be taken up at once, whilst the men were still at hand, and not left to be done after the bulk of the party had returned to recess quarters. Such re-surveys were also to be made by the sub-surveyor in fault, who received no pay whilst thus employed. This reduction in the amount of revision work, which has hitherto formed a large item in the following season's programme, does credit to the arrangements made by Captain Bythell.*

GEODETIC.

LATITUDE OPERATIONS.

No. 22 Party, Astronomical.

498. This party, under Captain Burrard, was employed on the observation of astronomical latitudes on the Abu Meridional and Jodhpore Meridional series; these series of the Great Trigonometrical Survey run approximately along the meridian of 72½°, and the astronomical latitudes of eight stations, situated near this meridian between the parallels of 23° and 27½°, were determined.

Personnel.

Captain S. G. Burrard, R.E., Deputy Superintendent, 2nd grade, in charge.
Aulad Hussein, Sub-Assistant Superintendent, 3rd grade.
Govind Balwant Joshi, Recorder.

499. The instrument used by Captain Burrard was one of the two zenith sectors designed by Colonel Strange for the Indian Survey, about 25 years ago. It arrived in India in 1871, a year later than its sister instrument, and has always been known as Zenith Sector No. 1. The sister instrument has been used repeatedly and has always given good results, but Zenith Sector No. 1 has only been used on one occasion previous to the present season. That occasion was in 1871-72, when Colonel W. M. Campbell, R.E., observed for latitude with it at eight stations of the Mangalore Meridional series. At each of those eight stations the zenith sector exhibited a "(N—S) difference," by which is meant that a difference was found to exist between the results by north and south stars respectively: the latitude derived from observations by north stars appeared always smaller than that from south stars. It thus became apparent that this zenith sector measured all zenith distances too large. Owing to this (N—S) difference, the zenith sector has been laid aside and discarded for 22 years, and not used again till the present season. In 1892-93 it was determined, after much consideration, to give it another trial, and Captain Burrard was directed, in using it, to supplement the ordinary observations for latitude with additional ones by what is usually known as Talcott's method. On the previous occasion, when it had been employed, the Talcott method of observation had not been introduced into the Indian Survey, and observations were consequently only taken with the sector method. It was hoped that if both systems were employed, the cause of the (N—S) difference might be discovered from a comparison of results. It is a significant fact, that this season, 1892-93, the zenith sector, after lying in its box for 22 years, has exhibited precisely the same (N—S) difference, as it did in Colonel Campbell's hands in 1871. Captain Burrard gives reasons in his narrative report (*vide* appendix) for thinking that this (N—S) difference is due to error of limb graduation and not to flexure of the telescopic tube. If it be due to flexure, the instrument must be regarded as useless; but if to error of graduation, it may be employed again with confidence. Captain Burrard has determined the amount of the error in the limb graduation, and has corrected his results accordingly; the corrected results exhibit no (N—S) difference, and

* Captain Bythell reports very favourably of his European Assistants.
Messrs. Dowman, George and Johnson, in chagre of camps, have carried on their duties with zeal and energy, whilst Mr. Rae has worked well.
Of the native establishment the following are considered worthy of special mention:—Taraprosonno Roy, Lall Mohun Gungopadhaya, Monohur Daji, Upendranath Mukerjee, writers; Narsu Dinkar, Karim Bux, Keshava Vaijnath, Gopal Sitaram, Gunpat Rai, and Natha Ram.

values of latitude obtained independently by the sector and Talcott methods never differ by more than o″96. The Deputy Surveyor-General feels confident that the (N—S) difference is not due to flexure, and has accordingly sanctioned the re-employment of this zenith sector in the forthcoming season of 1893-94.

500. A slight modification of the Talcott method was introduced this year by the observer: instead of making a "pair" of stars to consist of one north and one south star, in the manner laid down, a "pair" was occasionally composed of two north stars or two south: this modification was also extended to substituting *one* star for a pair, and to observing *one* star by Talcott's method instead of the usual pair. The star chosen had thus to be observed in *both* telescopic positions during its transit across the field of view. This modification and its extension to one star both gave good results.

501. The four northern stations at which latitudes were observed this season, *viz.*, Jambo, Chamu, Thob, and Samdari are situated in the Jodhpore desert; the general level of the desert does not vary, and there is an entire absence of mountains and hills: any deflection of the plumb-line must be consequently due to subterranean causes. The differences between the astronomic and geodetic values of latitude are given in Captain Burrard's narrative report, but these differences are not necessarily due to a local deflection of the plumb-line. The adoption of erroneous values of the earth's axis, any error in the initial azimuth of the Great Trigonometrical Survey, or any deflection of the plumb-line in the meridian at the station of origin and the survey, will cause differences to appear between astronomic and geodetic values. From the great predominance of negative values of this difference throughout the Indian Continent, it seems fairly certain that the plumb-line at Kalianpur, our station of origin, *has* an attraction in the meridian towards the south, and that all our geodetic values of latitude are consequently too large.

502. The very large number of stars, which have to be observed in consequence of employing Talcott's method, made the computations heavier than usual, and they were not completed till the second week of October. Some details of the season's work will be found in Captain Burrard's narrative report in the appendix, which is of great interest in exhibiting the forethought and skill with which he has succeeded in tracing out the cause of the (N—S) difference, and in applying a system of corrections for cancelling any evil effects that could arise from it. The extension of Talcott's method also, therein explained, which he has devised, is valuable in economizing time, and perfectly sound in principle.

503. The Deputy Surveyor-General inspected the party in the month of October, and found its condition to be in every way satisfactory.*

No. 23 Party, Astronomical.

504. This party was employed on latitude operations under Lieutenant Lenox-Conyngham on the Bombay Longitudinal series of triangulation, which runs eastward from Bombay along the parallel of 18°.

Personnel.
Lieutenant G.P. Lenox-Conyngham, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Babu Hanuman Prasad.
„ Lall Singh, recorder.

505. Before moving into the field, Lieutenant Lenox-Conyngham was directed to observe for latitude at Rajpur, and at the east end of the Dehra Base line, both stations situated near the foot of the Himalayas. A station situated between the two near the Dehra Survey Office already existed, at which the astronomical latitude had been observed, and latitude observations had also been taken at Mussooree. The deflection of the plumb-line, as exhibited in the differences between the astronomic and geodetic values of these four stations, is shown in the following table:—

Stations.	Astronomic Latitude $=\phi$			Geodetic Latitude $=\lambda$			Deflection of plumb-line $=\phi-\lambda$
	°	′	″	°	′	″	″
Dehra Dun Base Line	30	16	37·29	30	17	7·35	−30·06
Dehra Survey Office	30	19	19·56	30	19	57·07	−37·51
Rajpur	30	23	9·33	30	23	56·67	−47·34
Mussooree	30	27	4·02	30	27	40·55	−36·53

* Captain Burrard mentions favourably of Sub-Assistant Superintendent Aulad Hussein, and speaks highly of the services of Govind Balwant Joshi.

Of these four stations the first is situated on the northern slopes of the Siwaliks about 10 miles from the foot of the Himalayas and is 2,600 feet above sea level; the Siwaliks rise in the immediate rear to the height of about 3,000 feet. The station near the Dehra Survey Office is 2,200 feet above sea level and about 6 miles from the foot of the Himalayas. Rajpur is 3,500 feet above sea level, and actually *at* the foot of the Himalayas. Mussooree is 6,800 feet above sea level, and is situated on a peak of the sub-Himalayas.

506. The latitudes of seven stations on the Bombay Longitudinal series were subsequently observed, including the Bombay longitude station. The instrument used was the Zenith Telescope, and Talcott's method was employed throughout. About 50 pairs of stars were observed at each station, the mean probable error for the season being $\pm$ 0″056.

The most noticeable point in the results of the season's work is the extraordinary excess of the geodetic values of latitude over the astronomic, an excess that is becoming more and more apparent, as latitude operations are being extended.

507. Details of the season's work will be found in Lieutenant Lenox-Conyngham's narrative report in the appendix.

508. The office of the party was located at Mussooree under the same roof as that of the Deputy Surveyor-General, thereby affording ample opportunity for personal discussion of matters connected with the work. The party was formally inspected in October by the Deputy Surveyor-General and found to be in efficient working order.*

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

509. The direction of these operations was in the hands of Lieutenant-Colonel J. Hill, R.E., throughout the year, with the exception of the period from the 10th July to the 30th September, during which he was on privilege leave, and the operations were in charge of Lieutenant C. C. D. Morice, R.E. Colonel Hill reports upon Lieutenant Morice in the highest terms, mentioning particularly his satisfaction at the manner in which the work was carried on during his absence by that officer.

Personnel.

Lieutenant-Colonel J. Hill, R.E., Superintendent, 2nd grade, in charge up to 9th July 1893.
Lieutenant C. C. D. Morice, R.E., Officiating Assistant Superintendent, 1st grade, up to 22nd March 1893, and in charge from 10th July 1893.
Mr. G. Belcham, Extra-Assistant Superintendent, 3rd grade.
„ E. J. Connor, „ „ „ 4th „
„ J. Bond, „ „ „ 5th „

Surveyors, etc.

Dhondu Vinayek, Vinayek Narayen, N. V. Apte, 2 native mechanics and 16 recorders and computers.

TIDAL OPERATIONS.

510. The automatic recording of the tidal curves, their reduction, and the publication of the predicted times and heights of high and low water have been continued, and tidal observations by means of self-registering gauges have been carried on during the year at fourteen stations, *viz.*:—*Aden*, Muscat, Bushire, *Kurrachee*, Bhavnagar, *Apollo Bandar* (*Bombay*), Prince's Dock (Bombay), Minicoy, Tuticorin, Trincomalee, *Kidderpore*, *Rangoon*, Mergui, and *Port Blair*. The eight tidal stations whose names are not italicised are minor stations, where observations, as a rule, are taken for five years only. The others are permanent stations, where the minimum period of observations lasts for nineteen years, and where observations should be continued until the whole scheme of tidal operations has been completed. In addition to the automatic observations taken at the stations enumerated above, personal tidal observations to graduated staves were taken daily, with the object of comparing the actual heights and times of high and low water with those predicted in the Tide Tables. This was done at the following tidal stations, at all of which the tidal

* Lieutenant Lenox-Conyngham speaks highly of the services of Babu Hanuman Prasad and Babu Lal Singh, his recorder.

observatories are closed:—Cochin, Tuticorin, Colombo, Cocanada, Chittagong, Akyab, and Moulmein. At Galle the range of the tide is so small, and the water usually so rough, that precise personal observations are impracticable, but the Master Attendant has undertaken to report any appreciable error in the predictions.

511. Since the date of the last report one tidal observatory has been closed and two new tidal observatories have been established. At Tuticorin the observatory was closed on the 19th June 1893 after five years' registrations. At Muscat registrations were commenced on the 6th February 1893, and at Bushire on the 22nd November 1892.

Thus, since the resumption of systematic tidal operations in 1877, observations have been taken at 33 tidal observatories, of which 20 (including Madras) have been closed on the completion of their registrations, and 13 are now in operation.

512. It was reported last year that tidal observations were expected to commence during the field season of 1892-93, at the following four stations:—Diamond Island (Burma), Muscat (Arabia), Bushire (Persia), and Port Albert Victor in Bhavnagar. At Muscat and Bushire the observations have been successfully started; at Diamond Island the difficult, tedious, and expensive work connected with the erection of the observatory was completed just before the monsoon, and the instruments will be set up shortly. At Port Albert Victor, the lighthouse which Mr. Proctor-Sims, the Bhavnagar State Engineer, is building, and which will contain the tidal observatory, is at present far from completion. The assistance received from Mr. W. W. Squire, the Engineer to the Bombay Port Trust, has been most valuable. It was reported last year that he had forwarded observatories, etc., to Muscat and Bushire: these were erected in the field season, and proved just what was required. At Bombay also his assistance was most valuable: he erected a wooden case over the Apollo Bandar tide-gauge, took down the old observatory, and replaced it by a new one of a design in keeping with the neighbouring pavilion, without interrupting the tidal record for a single hour. At Prince's Dock he supplied workmen, and generally assisted the arrangements, by which the tide-gauge was removed from the upper story of the light-house and successfully re-started on the ground-floor. The Madras Harbour Trust have undertaken to bear the expense of a tidal observatory at that important permanent station. It is hoped that the tidal observations will shortly be resumed.

513. All the tidal observatories, without exception, have been inspected, and a detailed account of the working of each will be found in the appendix, where also certain circumstances deserving special notice are reported at Aden, Kurrachee, Apollo Bandar (Bombay), Prince's Dock (Bombay), Cochin, Tuticorin, Cocanada, Rangoon, and Moulmein. No serious interruption has occurred at any of the tidal observatories, though in several cases extensive improvements and repairs have been carried out. The tidal operations of the year may be pronounced very successful—a result due to a great extent to the assistance received from local officials whose kind co-operation has been acknowledged by Colonel Hill.

514. Colonel Strahan's standard sundials, recently introduced for readily ascertaining the correct noon at remote stations, have proved a very valuable adjunct to the instruments in use.

515. The reduction of the tidal observations have been carried on steadily during the year. Observations for one year at ten stations have been reduced, and for two years at two stations: the tabulated values of the tidal constants so obtained will be found in the appendix. In addition to these, constants to be employed in setting the tide-predictor were calculated for the year 1894 and sent to Mr. Roberts of the Nautical Almanac Office ready for use; he was also furnished with tabulated comparisons for the year 1892 between the predicted times and heights of high and low water at 15 stations, published in the Tide Tables for that year, and their values obtained by actual measurement, thus giving him in a convenient form information adapted to assist him in improving subsequent predictions, especially at the three principal riverain ports—Kidderpore, Rangoon, and Moulmein.

516. The Tide Tables for 1894 will contain predictions for 33 tidal stations; there are no new stations added since the last issue.

517. The usual tables showing the results of the predictions are given for the year 1892 in the appendix, and may be summarised as follows:—

Percentage of Time predictions within 15 minutes of actuals.

	High water, per cent.	Low water, per cent.
11 Open coast stations	77	76
4 Riverain stations	66	64

Percentage of Height predictions within 8 inches of actuals.

	High water, per cent.	Low water, per cent.
11 Open coast stations	93	88
4 Riverain stations	66	63

Percentage of Height predictions agreeing with actuals within one-tenth of mean range at springs.

	High water, per cent.	Low water, per cent.
11 Open coast stations	96	95
4 Riverain stations	91	91

These figures are very satisfactory, and show a high standard of accuracy in the predictions taken as a whole.

Spirit-levelling Operations.

518. The levelling operations of the last field season consisted of a continuous line of double levelling from Elephant Point to Rangoon, and thence to Mandalay, comprising the following sections:—

Section from Rangoon to Elephant Point.
Section from Rangoon to Mandalay.

The levelling was carried over ground the total rises and falls of which amounted to 6,893 feet, and the total outturn amounted to 464½ miles of double levelling, in the course of which the heights of 1 standard bench-mark, 431 permanent bench-marks, 54 railway bench-marks, 3 Public Works Department bench-marks, 3 Revenue Survey bench-marks, and 6 stations of the Great Trigonometrical Survey have been determined. This is an excellent outturn, and very creditable to Mr Bond who conducted the operations, especially as it was attained under most unfavourable climatic conditions, the particulars regarding which will be found in the appendix. Every assistance was given to the levelling detachment by Mr. G. F. Mathew, C.I.E., the Manager of the Burma State Railway, to whom Colonel Hill has expressed his obligations.

519. After effecting the crossing of the Rangoon river, the country was under water and the instrument had to be set up in from 6 inches to 2 feet of water: this did not affect the results, the accordance between the two levels being exceptionally close.

520. It is intended during next season to resume the levelling in India at Sakti Railway Station of the Bengal-Nagpur Railway and extend it *vid* Sambalpur along the line of the proposed railway to Cuttack, closing on Kendrapara, near False Point tidal station, and thus connecting the levels with Calcutta and False Point.

521. In addition to the regular departmental work of the tidal and levelling party, a considerable amount of extra work had to be undertaken in order to furnish other departments and Local Governments with information applied for by them, the particulars of which are given in the appendix.

522. The office of this party at Poona was inspected in September 1893 by the Surveyor-General, who was fully satisfied with the efficient state of the establishment.*

* Colonel Hill reports most favourably on Messrs. Belcham and Connor, and Surveyor Dhondu Vinayek in the tidal division, and of Mr. Bond and Surveyor Vinayek Narayen in the levelling division. Mr. G. H. Belcham, temporarily attached to the party, is favourably noticed, and the staff of native mechanics, surveyors, sub-surveyors, and computers are reported to have worked well and given satisfaction.

GEOGRAPHICAL SURVEYS.

OPERATIONS IN UPPER BURMA.

No. 11 Party.

523. The party continued in the charge of Colonel Woodthorpe throughout the year. Messrs. Kelly and Shaw joined the party while *en route* to the field. Mr. Kitchen had been suffering from illness for some time, and died at Fort Stedman before the party commenced field work.

Colonel R. G. Woodthorpe, C.B., R.E., Officiating Superintendent, 2nd grade, in charge.
Mr. F. Kitchen, Extra Assistant Superintendent up to 5th December 1892.
Mr. P. J. Doran, Extra Assistant Superintendent, 5th grade.
Mr. W. M. Kelly, Extra Assistant Superintendent, 6th grade.
Mr. H. G. Shaw, Sub-Assistant Superintendent, 2nd grade.

Surveyors and Sub-Surveyors.

Mahmud Hosein, J. Sebastian, Ramsabad, Kudratullah, Abdur Rahim, Sita Ram, Mowni Ram, Nuruddin, and three apprentices.

524. No regular survey could be undertaken, as two sections of the party were required to accompany the Commission for the demarcation of the boundary between Burma and Siam, and although a third section was formed to continue the regular survey of the Southern Shan States, the death, at the last moment, of Mr. Kitchen, who was to have had charge of this section, left it without any officer of sufficient experience to conduct operations. The members of this section remained at Fort Stedman till the end of February 1893, when they were taken to Mandalay by Captain Longe, R.E., who transferred some to No. 3 Party, and the remainder were employed on the drawing of district maps, etc.

525. The nature of the country and the means and time available prevented the survey work with the Commission being executed generally on a larger scale than 1 inch=4 miles. A good deal of the country passed over had already been well reconnoitred by the surveyors with previous boundary missions, and but little could be done in the way of topography beyond correcting the existing map in a few particulars of minor detail, though opportunities were taken, whenever they occurred, to fill up any gaps. In this way some new topography in Keng Tung was obtained, and also a somewhat considerable slice of Siam territory bordering the boundary. Triangulation was carried on as long as possible, *i.e.*, till the haze put a stop to it, after which a careful subtense or chain and compass survey was made of the routes taken by the different surveyors, and observations for latitude were taken at all well-known places and elsewhere, when necessary, as a check.

526. Colonel Woodthorpe, Mr. Kelly, and Sub-Surveyors Kudratullah and Abdur Rahim accompanied Mr. Hildebrand, the Commissioner in charge of the Mission on the eastern portion of the boundary. Messrs. Doran and Shaw, Sub-Surveyors Mahmud Hosein, Ramsabad, and Apprentice Sub-Surveyor Sheik Ali Hosein accompanied Mr. Leveson the Assistant Commissioner, on the western portion.

527. The party left Bangalore in the end of October 1892, reaching Fort Stedman in the end of November: this was made the head-quarters of the party for the winter. The members who accompanied the Boundary Demarcation Commission had all returned to Fort Stedman by the middle of May, and in the middle of June the office was opened in Bangalore for the recess.

528. The result of the season's operations is as follows:—

Triangulation	5,723	square miles.
Topography, ½-inch scale	5,853	do.
Ditto, 1-inch scale	165	do.
Traverses	1,162	linear miles.

529. Extracts from Colonel Woodthorpe's and Mr. Doran's narrative reports on the operations with the Boundary Commission will be found in the appendix.

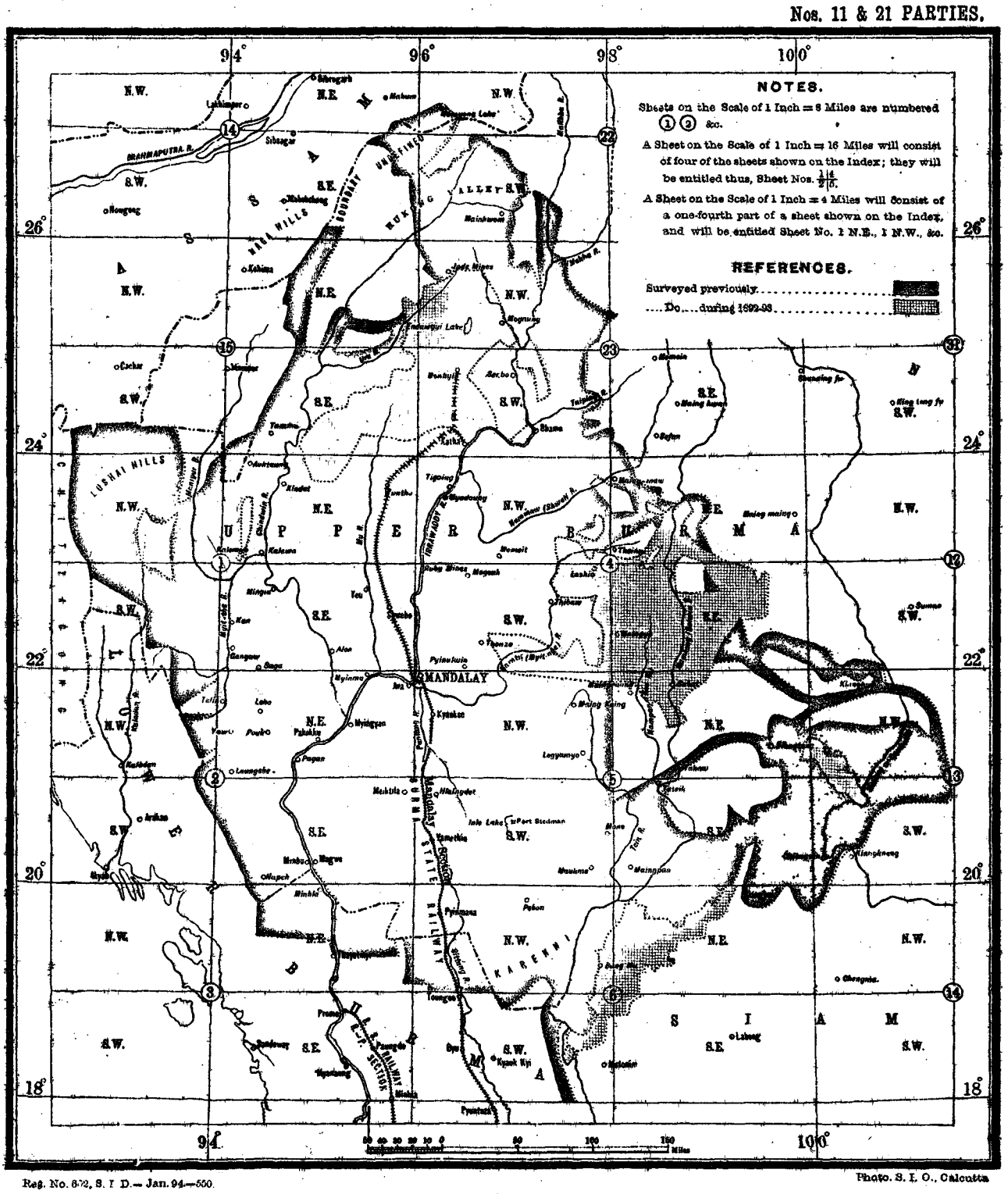
530. Before returning to Fort Stedman, a survey, on the scale of 10 inches =1 mile, of the new civil station of Taunggyi was made at Mr. Hildebrand's request by Colonel Woodthorpe and a sub-surveyor.

531. During the recess, Colonel Woodthorpe superintended the work generally, taking part in the computations and compiling the topography for the boundary maps, etc. Messrs. Doran, Kelly, and Shaw were employed principally

NORTH EASTERN & SOUTH EASTERN FRONTIER SURVEY.

INDEX TO THE GEOGRAPHICAL SURVEY IN UPPER BURMA.

Nos. 11 & 21 PARTIES.



Reg. No. 672, S. I. D.—Jan. 94.—550.

Photo. S. I. O., Calcutta

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on computations, and, when these were finished, Mr. Doran took a party for instruction into camp near Bangalore. Mr. Shaw was with him for some time for practice in plane-tabling. Mr. Sebastian and Abdul Rahim, surveyors, were engaged in drawing the fair maps.

532. A special map in three sheets has been drawn to show the boundary, and it only contains so much topographical information, in addition to new work, as is necessary for identification. It was considered unnecessary to do more than this, as it is probable that, during next winter's operations, opportunities for correcting the existing topography may be afforded; at any rate it will have to be brought into unison with the regular survey now being continued. It is hoped that the first survey of the whole of the Southern Shan States will be completed this winter, after which all the reconnaissance work already published will be re-drawn, and being combined with the regular survey can then be re-published in the usual standard sheets.

533. The recess office of the party was inspected at Bangalore during September by the Surveyor-General. Good progress had been made with the computations and mapping, and the general efficiency of the party was found to have been well maintained.

534. The programme for the next field season is to continue the survey of the Shan States, and to fill in the small gap still existing in the map of the Karenni country. A detachment will again be required for the Anglo-Siam boundary to complete the demarcation of the portion which was left unsettled.*

No. 21 Party.

535. The party, under Captain Renny-Tailyour, left recess quarters at Bangalore for the field during the last week of October 1892, and assembled at Mandalay early in November. On the 3rd February, 1893, Captain Longe, having returned from duty at the School of Military Engineering at Chatham, resumed charge of the party.

Personnel.

Captain F. B. Longe, R.E., Deputy Superintendent, 1st grade, in charge from 3rd February 1893.
Captain T. F. B. Renny-Tailyour, R.E., Deputy Superintendent, 2nd grade, in charge up to 2nd February 1893.
Captain C. F. Close, R.E., Officiating Deputy Superintendent, 2nd grade, from 6th May to 10th August 1893.
Mr. W. C. G. Barckley, Extra Assistant Superintendent, 6th grade.
Mr. J. M. Kennedy, Sub-Assistant Superintendent, 1st grade.
„ W. F. E. Adams „ „ 4th „

Surveyors and Sub-Surveyors.

Sher Shah, Ikbaluddin, Ali Nawaz, Mahomed Latif, Mahomed Alum, Mahomed Sayed, Mahomed Nawaz Khan, Natha Singh, and four apprentices.

Captain Renny-Tailyour remained with the party until April 22nd, when he proceeded to England on furlough.

536. The operations were of the same description as in former years, namely, geographical surveys and reconnaissances on the scale of 1 inch=4 miles.

537. The distribution of the party was as follows:—

Captain Renny-Tailyour and one surveyor to accompany Mr. Scott's expedition to the Northern Trans-Salween Shan States and the Wa country.

Mr. Barckley with Mr. Adams and four sub-surveyors to continue the triangulation and survey of the Katha and Upper Chindwin districts and certain portions of the Bhamo district.

Mr. Kennedy and four sub-surveyors to continue the survey of the Northern Shan States, principally in Northern Hsinwi.

538. The programme was considerably interfered with owing to the Kachin rising in the Northern Shan States, and though the topography was satisfactorily carried out by Mr. Barckley's squads, the triangulation was not extended northwards as was intended, nor was any connection made to the west with former

* Colonel Woodthorpe reports as follows regarding his assistants:—
"Mr. Doran conducted the operations entrusted to him with the Southern Boundary Party most creditably and with tact, and it was not owing to want of exertion that he failed to accomplish all he had hoped to do."
"Mr. Kelly carried out his duties with much energy in the face at times of considerable difficulty."
"Mr. H. G. Shaw worked willingly, but the work was quite new to him. I hope that, as he is anxious to do well, he will soon become a useful topographer. His knowledge of computations proved very useful."
With one exception, the native members of the party are also well reported on.

work, and considerable discrepancies were found between this and last year's work by Mr. Barckley's party, which will necessitate a considerable amount of revision survey.

539. Captain Renny-Tailyour with Surveyor Ikbaluddin covered a very large tract of hitherto but little known country, an area of over 5,000 square miles having been mapped, and his report on this portion of the work will be found in the appendix.

540. There is little of special interest to be reported during the year. Mr. Kennedy's detachment however had an exciting time in December and January, owing to an unexpected rising of the Kachins north-east of Lashio, which rising, owing to his prompt and plucky action in using his escort energetically against them, was rapidly suppressed. An interesting account of Mr. Kennedy's experiences during this disturbance will be found in the appendix; and it exemplifies the difficulties and dangers which surveyors meet with in Upper Burma even at the present time. Mr. Kennedy has been employed in that province since 1886, and his services therein have been of an exceptional character throughout. He has accompanied several military and political expeditions in which he has done a large amount of excellent work deserving high commendation.

541. The aggregate area surveyed during the year amounts to 17,982 square miles, on the ½-inch scale, in the following States and districts :—

	Square miles.
Northern Shan States	10,162
Katha district	4,203
Bhamo district	2,676
Upper Chindwin district	941
	17,982

542. The triangulation covered an area of 9,500 square miles, of which 6,000 are in the Shan States, and 3,500 in Katha and Bhamo districts.

543. Field work was continued much later this season than usual, as it was hoped to have completed the work remaining to be done in the Northern Shan States and Bhamo, and the party did not return to Mandalay till the end of May 1893. The consequence was that there was a considerable amount of sickness. During the year three men died—two of cholera and one of fever. The bulk of the party left Rangoon on the 2nd June 1893, and office opened for recess work in Bangalore on the 15th idem.

544. During the recess the computations have been completed, and the following new maps have been drawn :—

Map of Bhamo district,	scale 8 miles = 1 inch.	
„ Ruby Mines district	„ 4 „ „ 1 „	
„ Katha „	„ 4 „ „ 1 „	

also new editions of Sheets 1 N.E., 4 N.E., S.E. and S.W. of the S.E. Frontier Series ; and of Sheets 23 N.W., S.W., and 15 S.W. of the N.E. Frontier Series. The names on these maps have been most carefully revised, and it is hoped that few errors now remain; but owing to its being almost impossible to get the spelling correct in the first instance, this is a matter of the greatest difficulty.

545. A practical course of instruction in plane-tabling for apprentices was carried out under the supervision of Mr. Doran of No. 11 Party, who reports well on all of them.

546. The party was inspected at Bangalore in September 1893 by the Surveyor-General, who was well satisfied with Captain Longe's management of the party and with the arrangements for making the most use of all desultory work in compiling the standard and other maps of this Department for which he is responsible. The general efficiency of the party was well demonstrated.

547. The programme for next field season is as follows :—

To complete as far as possible the survey of the Upper Chindwin district, for which a detachment will be told off under Captain Gordon.

Mr. Kennedy will take a Detachment to the Northern Shan States to complete the survey there.

Captain Longe will accompany the Chin-Manipur Boundary Demarcation Commission, and one surveyor will accompany the Deputy Commissioner, Upper

Chindwin, to the country west of the Chindwin river. Another surveyor will accompany a column from Bhamo to the Sana country, west of the confluence of the branches of the Irrawaddy.

The remainder of the party under Mr. James will commence the survey on the 1-inch scale of the Southern Shan States.*

* Of the European assistants of the party, Captain Longe especially mentions Mr. Kennedy, whose prompt action in suppressing the rising of the Kachins entitles him to high praise. Mr. Adams is said to have shown marked improvement in field duties.

The native assistants are also as a whole well reported on.

Summary of the outturn of work of the

Scale of survey.	Number of party.	Locale of field operations.		TRIANGULATION.													
				Instrument used.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	Secondary—in which each angle is usually observed on two zeros.					Tertiary—in which two angles of each triangle are observed.			
									Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.
50 ft., 200 ft. and 400 ft.,=1 inch	7	Moulmein town	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64 inches=1 mile	8	Cuttack town	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32 inches=1 mile	6	Gauhati town	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Thaton town	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	Puri	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Garhwal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16 inches=1 mile	2	Chittagong	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Tippera	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Gaya	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bogra	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bankura	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Midnapur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Howrah	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Palamau	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	3	Shwebo	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Yeu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4 and 5	Muzaffarpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Champaran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Saran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Patna	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	Sylhet	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Tavoy	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Mergui	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Amherst	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Shwegyin	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	Balasore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Cuttack	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bilaspur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	9	Balaghat	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Raipur	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sambalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Minbu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Magwe	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Myingyan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forest)	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Garhwal Bhabar	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 inches=1 mile	3	Katha (Gold-fields)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay (Forest)	...	7"	245	209	3·5	3·9	210	488	11	0·2	210	238	447	0·3	238
6 inches=1 mile	15	Baluchistan	...	6"	15	7	0·5	0·5	8	12	18	1·8	8	50	70	1·7	50
4 inches=1 mile	2	Chittagong	40	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bankura	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	14	Nimar (Forest)	...	5", 6" & 7"	873	121	1·3	1·3	92	199	11	0·3	92	442	816	0·6	442
	17	Bombay (Forest)	...	6" & 7"	750	128	5·8	5·6	60	130	11	0·3	60	389	696	4·7	349
	18	Himalayas	...	7"	607	115	0·9	0·9	...	...	...	...	...	...	...	...	...
	19	Madras (Forest)	45	5" & 6"	3,430	377	3·1	3·1	287	698	15	0·5	287	840	1,699	1·2	840
	20	Lower Burma (Forest)	...	8"	300	8	75	75	4	5	10	...	4	...	...	...	...
2 inches=1 mile	10	South Maratha Country	...	8" & 10"	3,550	85	5·6	5·7	88	245	5·6	0·2	84	610	1,252	0·5	587
	12	Minbu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Himalayas	...	7" & 12"	559	86	1·4	1·4	83	162	13	0·3	83	314	587	0·5	314
	20	Lower Burma (Forest)	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Indus River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1 inch=1 mile	7	Mergui	...	5"	2,300	15	...	...	4	6	6·8	0·8	4	31	70	2·0	18
	Det.	Mergui	...	6"	1,500	12	...	...	10	13	19·4	1·3	10	12	17	3·0	10
	Det.	Indus River	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
½ inch=1 mile	11	Upper Burma	55	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	Baluchistan	...	8"	2,000	7	40	...	...	...	...	...	...	...	...	...	...
¼ inch=1 mile	11	Upper Burma	...	6"	5,723	34	...	...	16	29	40	1·1	10	30	52	1·1	20
	15	Baluchistan	...	6" & 8"	42,360	35	233	400	13	32	28	1·8	13	207	126	1·6	50
	21	Upper Burma	...	6"	9,500	44	40	57	...	...	...	...	...	193	408	1·4	124
	24	Upper Burma	00	12" (new)	1,260	8	...	...	...	...	...	...	...	...	...	...	...
	25	India and Burma	61	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Totals	...	...	74,972	1,291	...	...	875	2,019	...	...	865	3,356	6,240	...	3,024

Field Parties during the year 1892-93.

	SPIRIT-LEVELLING OPERATIONS.				TRAVERSING.*					DETAIL SURVEY.						REMARKS.
	Number of miles levelled over.	Number of permanent bench-mark stones embedded.	Number of Trigonometrical stations connected with lines of levels.	Number of permanent points fixed as bench-marks.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per station in seconds.	Average linear error per *mille*.	Square miles of village survey.	Area in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test lines.	Number of villages.	Number of fields.	Average size of field in acres.	
...	...	...	...	...	...	...	...	...	...	9	...	...	...	16,172	...	
...	...	...	...	...	...	...	...	...	...	4	...	...	35	36,805	...	(*a*) Calculated on the cultivated portion only.
...	...	...	...	...	220	22	9	...	5	3	...	...	2	3,633	0·61	
...	...	...	...	...	...	...	...	...	...	4	...	...	...	6,356	...	(*b*) Tested *in situ*.
5	...	...	...	...	...	...	...	...	...	10	...	...	...	...	0·48	
...	...	...	...	...	774	127	6	0·4	34	270	...	1,755	1,194	794,623	0·22	
...	...	...	...	...	11,812	1,370	0·4	...	88	159	...	347	70	732,273	0·51	
...	...	...	...	...	13,068	2,069	...	0·5	407	293	...	1,172	753	359,618	0·52	
...	...	...	...	...	4,752	1,504	1·2	...	271	...	...	...	...	...	...	
10	...	...	...	...	4,010	420	...	...	60	13	...	66	22	14,000	0 60	
...	...	...	...	...	2,891	457	...	...	126	...	...	...	...	...	...	
...	...	...	...	...	1,748	385	10	...	57	57	...	156	92	97,000	0·38	
...	...	...	...	...	2,914	379	...	...	76	43	...	93	92	32,338	0 85	
...	...	...	...	...	1,355	228	...	...	38	...	...	...	...	...	...	
15	...	...	...	...	13,257	1,731	5	0·5	870	1,559	...	2,566	242	762,170	1·21	
...	...	...	...	...	20,451	3,206	13	0·7	942	207	...		231	132,614	...	
...	...	...	...	...	12,491	3,052	1·0	0·7	997	529	...	2,072	1,153	731,277	0·47	
...	...	...	...	...	18,372	4,089	1·4	...	1,103	416	...	1,900	244	359,644	0·74	
...	...	...	...	...	19,161	3,859	1·9	0·4	894	...	...	...	...	...	...	
20	...	...	...	...	624	87	...	...	62	...	...	...	...	...	...	
...	...	...	...	...	2,734	375	4	0·8	153	484	...	1,353	550	257,665	1·20	
...	...	...	...	...	1,381	156	3	0·6	39	88	...	200	75	19,783	0 62(*a*)	
...	...	...	...	...	10,999	1,324	3	0·4	225	127	...	122	344	53,877	0·79(*a*)	
...	...	...	...	...	7,597	1,164	3	0·9	385	688	...	1,616	433	43,2686	0·47(*a*)	
25	...	...	...	...	3,073	658	10	0·9	180	...	...	...	...	...	...	
...	...	...	...	...	34,290	5,142	6	2·6	1,074	1,093	...	3,919	2,057	1,437,117	0·49	
...	...	...	...	...	...	...	...	...	...	470	...	2,192	862	622,461	0·50	
...	...	...	...	...	17,725	2,834	4	}	740	...	...	...	...	...	...	
...	...	...	...	...	2,415	301	4		171	...	...	...	...	...	...	
30	...	...	...	...	24,827	4,055	4	0·2	879	...	...	...	...	...	...	
...	...	...	...	...	13,092	2,241	4	}	526	...	...	...	...	...	...	
...	...	...	...	...	2,258	259	5	0·4	38	465	...	832	109	83,288	3,57	
...	...	...	...	...	30,557	4,479	4	0·4	1,140	750	...	1,630	337	487,421	0·98	
...	...	...	...	...	...	...	...	...	...	12	...	20	5	4,510	1·72	
35	...	...	...	...	3,312	500	0·4	0·8	...	22	...	22	...	...	...	
...	...	...	...	...	191	34	7	0·2	6	18	...	24	61	3,928	2·98	
...	...	...	...	...	...	...	...	...	...	6	...	...	...	...	...	
...	...	...	...	...	218	34	11	0·8	...	185	557	150	...	...	...	
...	...	...	...	...	...	...	...	...	...	19	132	10	...	...	...	
40	...	...	...	...	...	...	...	...	464	...	...	...	...	...	...	Skeleton boundary survey.
...	...	...	...	...	8,610	...	...	...	783	...	...	...	...	...	...	
...	...	...	...	...	3,407	605	11	1·8	...	628	68	330	...	...	...	
...	...	...	...	...	...	...	...	...	...	220	114	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	475	37	(*b*)	...	...	...	
45	...	...	...	...	1,894	139	21	4·0	...	788	35	(*b*)	...	...	...	
...	...	...	...	...	10,979	508	7	7·0	...	214	201	69	...	...	...	
...	...	...	...	...	3,095	1,351	8	0·6	1,435	2,778	0·14	295	...	...	...	
...	...	...	...	...	...	...	...	...	...	25	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	212	36	(*b*)	...	...	...	
50	...	...	...	...	...	...	...	...	...	113	74	10	...	...	...	
...	...	...	...	...	316	140	0·3	0·3	...	127	9	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	610	2·3	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	679	8·4	...	...	...	...	
...	...	...	...	...	4,708	1,470	0·3	0·5	1,106	1,114	8·0	75	...	...	...	
55	...	...	...	...	...	...	...	...	...	165	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	4,605	1·4	(*b*)	...	...	...	
...	...	...	...	...	...	...	...	...	...	5,853	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	60,120	0·03	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	17,982	...	...	...	...	...	
60	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Trigonometrical operations only.
61	465	432	7	60	...	...	...	...	...	...	...	...	...	...	...	
...	465	432	7	60	315,560	50,754	...	...	15,414	1,04,711	...	22,996	8,954	7,481,259	...	

Statement showing the cost-rates of work executed by the

Number of party.	Nature and *locale* of field operations.	Cost-rate per square mile in rupees.								
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of						
				½″	1″	2″	4″	6″	8″	16″	32″
	Topographical Surveys.										
10	South Maratha Country	6·2	5·0	...	...	16·1	...	...	...	...	...
12	Minbu	...	...	...	...	26·1	...	...	...	...	...
15	Baluchistan	...	...	8·2	...	...	...	145·6	...	...	...
18	Himalayas	15·7 16·2	.. ...	... ...	... ...	47·6 ...	... 72·1	... ...	... ...	... ...	... ...
Det.	Mergui	...	...	...	42·9(*d*)	...	...	...	...		...
Det.	Indus River	...	12·2	...	9·2	...	...	...	..	...	...
	Forest Surveys.										
14	Nimar	19·0	21·5	...	...	...	99·5	...	...	...	...
17	Bombay	13·0	21·7	...	...	...	80·6	...	150·4	189·7	...
19	Madras	7·5		...	...	...	70·5	...	...	...	...
20	Lower Burma	33·2	138·1	...	...	61·0	160·1	...	...	...	...
	Cadastral Surveys.										
2	Chittagong	...	62·4	...	...	...	...	...	...	206·6	...
2	Tippera	...	32·9	...	...	...	...	...	...	132·7	...
2	Gaya	...	36·2	...	...	...	...	...	...	...	...
2	Bogra	...	53·6	...	...	...	...	...	...	147·8	...
2	Bankura	...	74·2	...	...	...	...	...	...	...	...
2	Midnapur	...	44·8	...	...	...	...	...	...	118·0	...
2	Howrah	...	48·2	...	...	...	...	...	...	143·6	...
2	Palamau	...	15·2	...	...	...	...	...	...	...	...
3	Shwebo	...	42·6	...	...	...	...	...	...	83·4	...
3	Yeu	...	42·3	...	...	...	...	...	...	69·7	...
4 & 5	Muzaffarpur	...	30·7	...	...	...	...	...	...	78·7	...
4 & 5	Champaran	...	24·4	...	...	...	...	...	...	78·9	...
4 & 5	Saran	...	29·3	...	...	...	...	...	...	...	...
6	Sylhet	...	27·3	...	...	...	...	...	...	68·8	...
7	Tavoy	...	...	...	...	...	...	...	...	209·3(*t*)	...
7	Mergui	...	139·2	...	...	...	...	...	...	138·3	...
7	Amherst	...	58·3	...	...		...	...	...	155·1	...
7	Shwegyin	...	52·0	...	...	...	...	...	...	...	...
8	Balasore	...	35·0	...	...	...	...	...	..	68·8	...
8	Cuttack	...	...	...	...	...	...	...	...	65·7	...
12	Minbu	...	66·3	...	...	...	...	...	...	117·3	...
12	Magwe	...	59·3	...	...	...	...	...	...	123·7	...
Det.	Garhwal	...	36·4	...	...	...	...	...	...	...	286·3
	Traverse Surveys.										
2	Bankura	...	33·8	...	...	...	...	...	...	...	...
2	Chittagong	...	94·5	...	...	...	...	...	...	...	...
9	Bilaspur, Balaghat, Raipur, and Sambalpur.	.....	25·9	...	...	...	...	...	...	...	...

everal Field Parties during the year 1892-93.

Cost-rate for traversing, detail survey and preparation of maps.	Cost-rates. Stone embedding.	Records (*Khanapuri*).	Completion of vernacular records, assessment statistics, etc.	Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
Per acre.	Per square mile.	Per square mile.	Per square mile.		
a. p.	₹	₹	₹	₹	
...	...	...	...	84,986(*a*)	(*a*) Includes ₹11,074 expended on Gujarat Survey General Degree Reports.
...	...	...	...	652	
...	...	...	...	1,34,421(*b*)	(*b*) Includes ₹82,383 expended on 4-inch geographical surveys; ₹1,200 on triangulation for 6-inch survey; and ₹10,100 on traversing for 16-inch settlement survey.
...	...	...	...	76,368(*c*)	(*c*) Includes ₹5,737 expended on special forest survey of the Simla Hill States; ₹748 on Kalka town survey; ₹1,711 on instruction of soldier surveyors; ₹1,460 on survey schools; and 11,949 on arrears of mapping.
...	...	...	...	55,379	
...	...	...	...	24,610(*e*)	(*d*) Includes cost of triangulation.
					(*e*) Includes ₹811 expended on Sind-Bhawalpur boundary.
					(*f*) Includes ₹6,278 expended on classification of forest and soil of 628 square miles; and ₹141 on the revision survey and fair mapping of the town and cantonment of Dehra Dun.
					(*g*) Includes ₹16,581 expended on demarcation; and ₹443 on instruction of *amins*.
					(*h*) Includes ₹4,377 expended on demarcation; ₹1,827 on instruction of *amins*; and ₹1,190 on stone-embedding.
...	...	...	...	1,00,383(*f*)	(*i*) Includes ₹1,297 expended on demarcation.
...	...	...	...	73,729	(*j*) Includes ₹2,013 expended on demarcation.
					(*k*) Includes ₹1,272 expended on demarcation.
					(*l*) Includes ₹371 expended on demarcation.
					(*m*) Includes ₹137 expended on demarcation; and ₹285 on instruction of *amins*.
...	...	...	...	81,068	(*n*) Includes ₹1,742 expended on Manipur boundary survey.
...	...	...	...	1,08,597	(*o*) Includes ₹3,263 expended on Katha gold fields survey.
					(*p*) Includes ₹3,917 expended on demarcation; and ₹1,221 on instruction of *amins*.
					(*q*) Includes ₹47 expended on demarcation; ₹2,933 on instruction of *amins*; excludes ₹11,125 on Jalpaiguri mapping; and ₹1,453 on 4-inch skeleton survey of Katora State.
					(*r*) Includes ₹328 expended on demarcation; and ₹2,366 on instruction of *amins*.
					(*s*) Includes ₹2,260 expended on revision; ₹2,377 on instruction of local officers and *amins*; and ₹2,927 on 2-inch mapping.
6 9	...	...	...	82,201	(*t*) Includes cost of traversing of 39 square miles.
4 1	...	102·4	93·3	94,923(*g*)	(*u*) Includes ₹303 expended on demarcation; and ₹1,688 on revision survey.
...	...	...	...	17,684(*h*)	(*v*) Includes ₹1,748 expended on demarcation; and ₹1,844 on revision survey.
5 0	...	...	...	6,436(*i*)	(*w*) Includes ₹2,992 expended on demarcation; ₹7,918 on Moulmein town survey; ₹1,920 on Thaton town survey; ₹2,022 on 2-inch mapping; and ₹5,167 on revision survey.
...	...	...	...	11,366(*j*)	(*x*) Includes ₹1,399 expended on demarcation.
4 1	...	45·3	...	11,138(*k*)	(*y*) Includes ₹2,028 expended on demarcation.
4 10	...	67·8	...	11,591(*l*)	(*z*) Includes ₹11,256 expended on revision survey; ₹1,371 on 2-inch mapping; and ₹3,251 on Cuttack town survey.
	...	...	...	1,001(*m*)	(*a1*) Includes ₹156 expended on revision survey.
3 2	4·2	...	7·1	1,83,500(*n*)	(*b1*) Includes ₹111 expended on revision of Lansdowne forest; ₹494 on surveys in the Bhabar; and ₹1,829 on revision of traverses of 1889-92.
2 10	4·1	...	...	61,491(*o*)	
2 9	4·0	30·8	42·6	1,14,928(*p*)	
2 7	3·4	16·0	14·2	71,836(*q*)	
...	8·9	...	...	36,893(*r*)	
2 5	...	...	44·3	66,447(*s*)	
5 3	...	...	...	20,408(*u*)	
6 11	...	...	...	52,476(*v*)	
5 4	...	...	...	1,49,160(*w*)	
...	...	...	...	10,759(*x*)	
2 7	9·3	13·5	21·1	1,63,363(*y*)	
1 8	...	46·1	38·5	1,41,159(*z*)	
4 7	5·8	13·3	...	63,755	
4 7	4·1	13·0	...	1,74,728(*a1*)	
8 1	...	...	...	80,978(*b1*)	
...	...	...	...	30,351	
...	...	...	...	43,851	
...	8·3	...	...	79,253	

Particulars of Cadastral Surveys completed since 1891-92.

District.	Scale of Survey.	Number of villages.	Number of fields.	Area surveyed in square miles.	Average size of fields in acres.	Cost, exclusive of demarcation and charge for instruments.	Rate per square mile.			By whom and when surveyed.
							Traverse Survey.	Cadastral Survey.	Cadastral Survey with Record of Rights.	
						R	R a. p.	R a. p.	R a. p.	
Assam Valley Districts	16" = 1 mile	5,268	1,980,565	5,218	1·69	8,85,473	34 5 4	...	125 5 11	Mr. E. C. Barrett, during 1883—93.
Tavoy (portion only)	"	417	304,336	398	0·56	92,160	93 0 0	127 0 0	...	Mr. C. Wood, during 1891—93.
Chittagong (portion only)	"	1,219	6,580,466	1,591	0·15	4,31,550	49 8 9	205 2 9	...	Col. E. H. Steel, Mr. F. Grant, Mr. W. J. O'Sullivan, during 1888—93.

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

548. These offices comprise,—

(1) The Head-quarters offices at Calcutta.
(2) The Trigonometrical Branch office at Dehra Dun.
(3) The Drawing office at Simla.

A detailed description of the work carried on in each office is given below:—

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE AND ACCOUNTS.

Superintendence.

Colonel H. R. Thuillier, C.I.E., R.E., Surveyor-General of India.
Colonel G. Strahan, R.E., Officiating Surveyor-General of India, up to 2nd November 1892.
Lieutenant-Colonel C. Strahan, R.E., Deputy Surveyor-General, in charge Revenue Branch.
Lieutenant-Colonel J. E. Sandeman, S.C., Director of Bengal Surveys.
Lieutenant-Colonel M. W. Rogers, R.E., Assistant Surveyor-General, up to 18th April 1893.
Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, from 19th April 1893.
Mr. T. Archdale Pope, Deputy Superintendent, 2nd grade, Personal Assistant to the Surveyor-General, from 23rd November 1892 up to 30th April 1893.*
Mr. T. W. Babonau, Registrar.

Correspondence.

Mr. T. A. Milne, Head Assistant, from 1st December 1892.
„ G. C. Walker, Head Clerk, from 21st December 1892.
„ J. A. Vallis, Clerk, up to 23rd Febuary 1893.
Babu Kali Podo Banerji, Clerk.
„ Bani Madhub Banerji, Clerk.
„ Durga Narain Ghose, „
„ Ram Kisto Chunder, „
„ Chuni Lal Dey, „
„ Gopal Chunder Dass, „
Mr. E. Bonnaud, „
Babu Kali Kristo Chunder, „ and 8 others.

Accounts.

Mr. C. O. Gray, Head Clerk.
„ T. Ware, Clerk.
Babu Raj Krishna Mukerji, Clerk.
Mr. E. D'Cruz, Clerk.
Babu Hem Nath Dutt, Clerk and 6 others.

549. The general direction of these offices remained in the hands of Colonel H. R. Thuillier, R.E., except during his absence on privilege leave up to the 2nd November 1892, when Colonel G. Strahan, R.E., officiated for him as Surveyor-General. The Revenue Branch section continued under the superintendence of Lieutenant-Colonel C. Strahan, R.E., throughout the year, and the General and Topographical Branch sections under that of Lieutenant-Colonel M. W. Rogers, R.E., and Colonel W. H. Wilkins, S.C. at different times. Mr. T. A. Pope held the office of Personal Assistant to the Surveyor-General.

Lieutenant-Colonel J. E. Sandeman, S.C., Director of Bengal Surveys, returned from furlough on the 20th October 1892 and resumed the superintendence of the Bengal Branch section from that date.*

* The Assistant Surveyor-General reports as follows:—
"The general superintendence of the office has been satisfactorily carried on by Mr. T. W. Babonau, the Registrar. Messrs. Milne and Gray have also carried on their duties to my satisfaction, and the arduous duty of arranging for, and shipping to Burma, the Survey *khalasis* has been well performed by Mr. J. A. Vallis.
"The clerks have also worked well, and the following are deserving of special mention:— Babus Bani Madhub Banerji, Chuni Lal Dey, Raj Krishna Mukerji, Kanti Chunder Sen, and Mohendro Chunder Aich."
The Deputy Surveyor-General reports that in the Revenue Branch Office Mr. Walker has performed his duties satisfactorily, considering he has had only a year's experience as a clerk, and Babus Kali Podo Banerji, Ram Kisto Chunder, and Norendro Nath Mukerji have worked well and steadily.

DRAWING OFFICE.

550. The Drawing Office remained in the charge of Colonel W. H. Wilkins, S.C., up to the 18th April 1893, after which it was at different times under the superintendence of Major R. A. Wahab, R.E., Mr. T. A. Pope and Captain C. F. Close, R.E.

551. Mr. S. M. Smylie held the post of Chief Draftsman throughout the year, and during his absence on privilege leave from the 11th April to the 5th July 1893, the Head Draftsman, Mr. L. Pocock, acted for him.

552. The Drawing Office is divided into three sections, which are reported on separately, and a detailed statement of the work completed in each section is given in the appendix.

Personnel.

Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, in charge up to 18th April 1893.
Major R. A. Wahab, R.E., Officiating Assistant Surveyor-General, from 19th April to 9th July 1893.
Mr. T. A. Pope, Officiating Assistant Surveyor-General, from 10th July to 16th August 1893.
Captain C. F. Close, R.E., Officiating Assistant Surveyor-General, from 17th August 1893.
Mr. S. M. Smylie, Chief Draftsman.
Mr. L. J. Pocock, Head Draftsman, and Officiating Chief Draftsman, from 11th April to 5th July 1893
Mr. A. G. Wyatt, Officiating Head Draftsman, from 11th April to 5th July 1893 and from 15th July to 14th October 1893.
Mr. G. D. Cusson, Draftsman, up to 31st July 1893.

Mr. W. Green,	Draftsman.
„ A. J. Musgrove,	„
„ J. R. Adels,	„
„ R. C. Sinclair,	„
„ A. S. Bateman,	„
„ A. J. Rodrigues,	„
„ N. G. Watson,	„
„ A. Wilson,	„

Native Draftsmen.

Babu Harihur Sen up to 9th March 1893. Retired.
Babu Mohesh Chandra Shaw.
Munshi Muttiullah.
Babu Purna Chandra Sen.
„ Gopal Chandra Roy.
Munshi Meher Ali up to 7th May 1893.
Babu Tin Cowry Sen.
Babu Becharam Banerjee.
„ Ram Chandra Sen.
„ Sarat Chandra Chatterji, and 50 others.

Additional Establishment.

Mr. A. J. James, Draftsman, and 7 others.

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty.

Mr. A. G. Wyatt, Extra Assistant Superintendent, 2nd grade.
Mr. G. Campbell, Extra Assistant Superintendent, 4th grade, up to 30th March 1893.
Mr. J. Barker, Extra Assistant Superintendent, 5th grade, from 5th June 1893.
Mr. G. D. Cusson, Extra Assistant Superintendent, 5th grade, from 1st August 1893.
Mr. C. W. Wilson, Extra Assistant Superintendent, 6th grade.
Mr. C. W. F. Seyers, Extra Assistant Superintendent, 6th grade.
Mr. E. J. Martin, Sub-Assistant Superintendent, 1st grade, up to 14th March 1893.
Mr. R. F. Warwick, Sub-Assistant Superintendent, 1st grade, from 18th February to 27th March 1893.
Mr. W. H. Penrose, Sub-Assistant Superintendent, 1st grade, from 10th November 1892 to 31st May 1893.
Mr. M. F. Berkeley, Sub-Assistant Superintendent, 3rd grade, from 16th June to 23rd September 1893.

SECTION 1.—GEOGRAPHICAL DRAWING AND COMPILATION.

553. The principal work of this section has been the preparation of the maps of Burma on various scales. New editions of three sheets on the 8-mile scale, *viz.* Nos. 15 and 22 of the North-East Frontier series and No. 7 of the South-East Frontier series, have been prepared and published, the two former from the latest edition of the quarter-inch maps, and the last from material obtained through the Quarter Master-General's Department. New editions also of sheets Nos. 1, 4 and 6, South-East Frontier series and Nos. 22 and 23 of the North-East Frontier series, are in progress, as well as a new compilation of sheet No. 5, South-East Frontier series.

554. On the quarter-inch scale, sheets Nos. 15 N. W. and 15 S. W., North-East Frontier series, and 2 N. W. and 2 S. W., South-East Frontier series, are in progress, whilst new editions of sheets Nos. 1 N. W. and 1 S. W., South-East Frontier series, have been prepared and published with additional materials supplied by the Quarter Master General's Department.

555. The map of Upper Burma on the scale of 1 inch = 16 miles, referred to in paragraph 479 of last year's report, has been completed and published.

556. A new map of Indo-China, east of longitude 92°, on the 32-mile scale, the preparation of which was considered advisable by the increasing interest and prominence of events in that part of the country, was commenced and rapidly executed. It is prepared for publication in two colours, and will be ready for issue while this report is passing through the press.

557. The third edition of the 32-mile map of India is still held in abeyance in consequence of the want of orders from the Government of India regarding the frontier boundaries that are to be inserted. Advantage will be taken of this unavoidable delay to bring the map up to date.

558. Nine statistical maps of India on the 32-mile scale, required by the Revenue and Agricultural Department for exhibition at the Imperial Institute, were drawn and completed. A duplicate set of these maps for the Antwerp Exhibition was also commenced in August. The preparation of such special maps for other departments taxes the resources of the Drawing Office to a large extent, and necessitates the regular departmental work being temporarily set aside and consequently delayed.

559. The provincial maps of the Bombay and Madras Presidencies, which have been commenced at the request of the Secretary of State for India to complete the series of provincial maps on the 8-mile scale, have engaged a considerable portion of the establishment. The map of the Bombay Presidency, which is on one sheet, and one of the five sheets required for the map of the Madras Presidency, are in progress.

560. The remaining maps, six in number, required by the Foreign Department for the new edition of Aitchison's Treaties, were completed and published.

561. Four sketch maps, one plan, and two route surveys of Somali land were drawn for reproduction and completed for Captain Swayne, R.E.

562. The demands on the Drawing Office continue to increase, and the large amount of requisitions for the preparation of maps of every kind outside the regular work of the department occupies the time of all the best draftsmen. There has been an increase in the staff of the Drawing Office, but sufficient time has not elapsed for the full complement of suitable men to be found nor for the training of those who have joined. The experiment of obtaining pupils from the Calcutta School of Art, which was referred to in last year's report, has not as yet proved successful. Though the four pupils taken on probation had done very good general drawing in the school, they did not evince any aptitude for topographical drawing or hand-printing, and after some months' trial three out of the four pupils were discharged, only one being retained for further training. The Superintendent of the School of Art will in future arrange for the pupils desirous of entering this Department to have opportunities given them while at the school of learning topographical drawing and hand-printing, so that they will come as probationers with a certain amount of the technical skill required for the work of the Department.

SECTION II.—REVENUE.

563. The work in this section consists in examining and preparing for photo-zincography the fair maps received from the field parties of the Revenue Branch, in republishing old maps after bringing them up to date, and in supplying data.

564. Two 1-inch scale standard sheets of the Punjab, as well as one of the North-Western Provinces, have been compiled up to margin for a second edition. The compilation on graticule in 1-inch scale standard sheets of the old district maps of Lakhimpur, in the province of Assam, have been completed for a second edition, and those of district Sibsagar have been commenced.

565. A map of the environs to the east and south of Calcutta, to be incorporated with the existing 6 inches to the mile map of the city, has been compiled from old data, and after it has been brought up to date by the insertion of new roads and buildings, etc., it will be published during the coming year.

566. A very large amount of work has been done as usual for other departments. A map of the Kadana state was compiled from the standard sheets of the Bombay Survey on the scale of 2 inches = 1 mile for the Political Agent of Rewa Kantha. Five similar maps of the Angul estate in Orissa were compiled for the Conservator of Forests, Bengal, and a map of the Central Provinces, on the scale of 1 inch = 32 miles, for reduction to half scale, was compiled and published for the Census Commissioner to illustrate his report.

567. The maps of the city of Mandalay and environs, on the scale of 1 inch = 1 mile, were prepared from the standard sheets of No. 3 Party, one with and the other without boundaries. The former was required as a general map for the public, while the latter was prepared specially for the use of the military authorities, for whom also another map of Mandalay, including a 10-mile-radius of country from the city was prepared.

568. Two sheets comprising the Lansdowne Forest Reserve in district Garhwal of the North-Western Provinces, on the scale of 4 inches = 1 mile, are in progress, and the forest survey sheets of district Jalpaiguri in the Western Duars, 48 in number, were completed and published in 33 blocks for the Forest Department.

569. In the North-Western Provinces the drawing of the ½-inch scale district maps has made considerable progress. The map of district Mirzapur was sent to press; the drawing of the sheets of district Garhwal is well advanced, while the map of district Almora has been commenced. The publication of the map of district Gorakhpur has been delayed owing to the proofs not having been returned by the local officials to whom they were sent for examination.

570. The examination of the computations of the field parties has not made much progress during this year, owing to the computing section being so often employed on other miscellaneous work: 250 cases of correspondence have been dealt with, necessitating copies of old data after much scrutiny. The records of only two districts, Lalitpur and Nagpur, were examined, as well as the records of the Angul Government estate and the Nepal-Pilibhit boundary.

SECTION III.—CADASTRAL.

571. This section in employed is preparing the original maps of all the cadastral surveys for zincography and photo-zincography. The procedure is to examine the numbering of the fields and to observe if all holdings and divisions of land are correctly tabulated in the area statements. The total number of maps passed for publication during the year was 5,440, of which 5,426 were actually printed, 3,965 having been photo-zincographed and 1,461 zincographed; this shows an increase of 529 on the publications of the previous year. Of the printed maps 1,584 were coloured and, after examination, sent for record with the Settlement Officers of the districts to which the maps appertained.

572. The original maps have been arranged and bound into 52 volumes for record in this office, and 68 volumes of printed cadastral maps of district Thongwa (Lower Burma) and Kyaukse (Upper Burma) have been arranged in circles and townships, and forwarded to the Chief Commissioner of Burma.

573. It was not found possible to undertake any reprints of former published maps in consequence of the urgent demands for the first prints of maps of the North-Western Provinces, Burma, and Assam, though a long list of villages for which reprints are required has been received from the Superintendent, Government Printing, Allahabad.

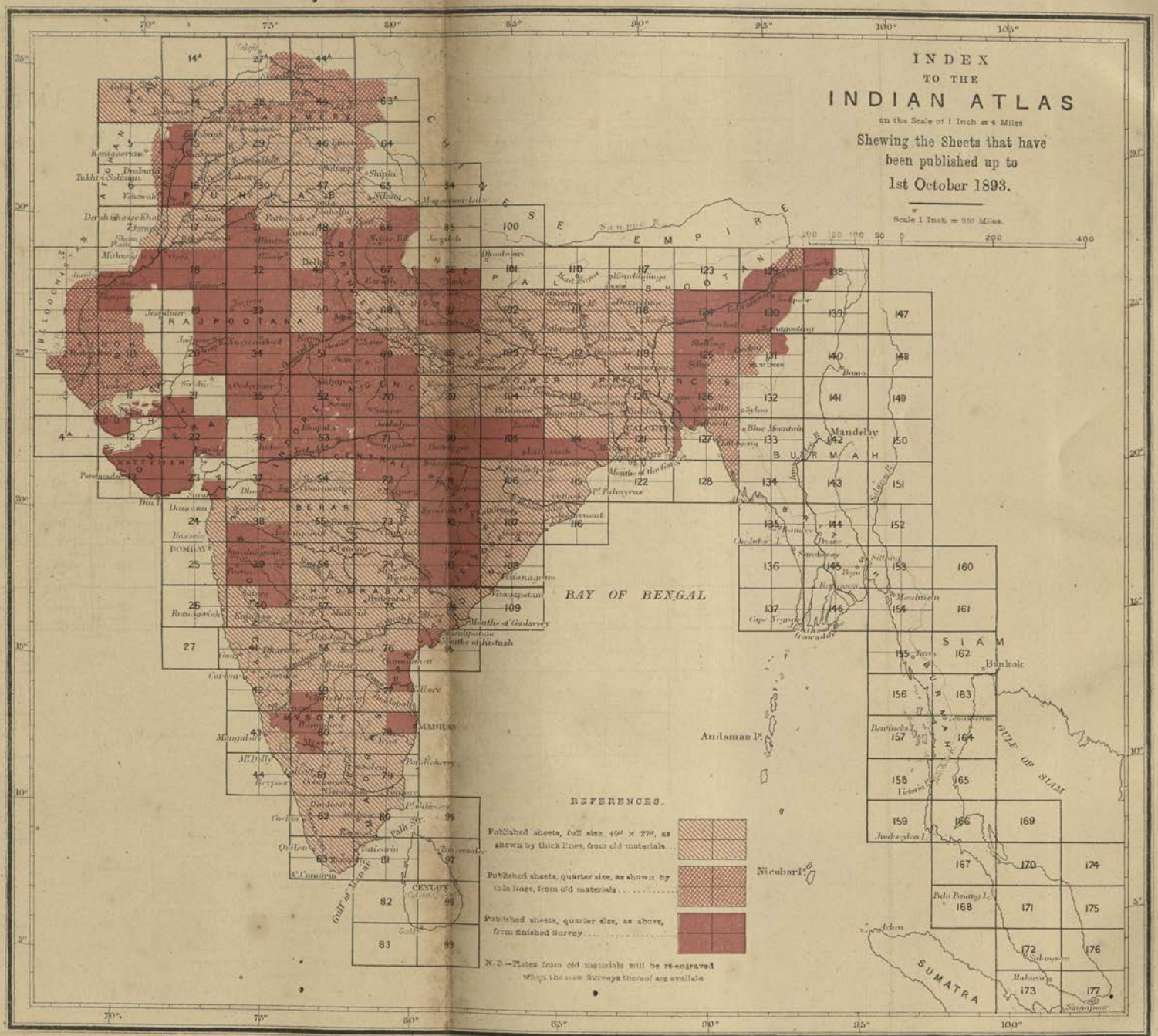
574. The 6 remaining sheets of district Gorakhpur and 14 of Mirzapur in the North-Western Provinces have now been published, and there are therefore no maps of old surveys now left for publication.

575. At the close of the year there were only 3,095 sheets in this office for publication, against 4,634 in last year, showing a decrease of 1,539. As the surveys in the North-Western Provinces, the sheets of which have hitherto engrossed the office, come to an end this year, the cadastral establishment will be able after next year to complete the publication of all maps of Burma and Assam as received without falling into any arrears.*

* Colonel Wilkins reports as follows on his assistants:—

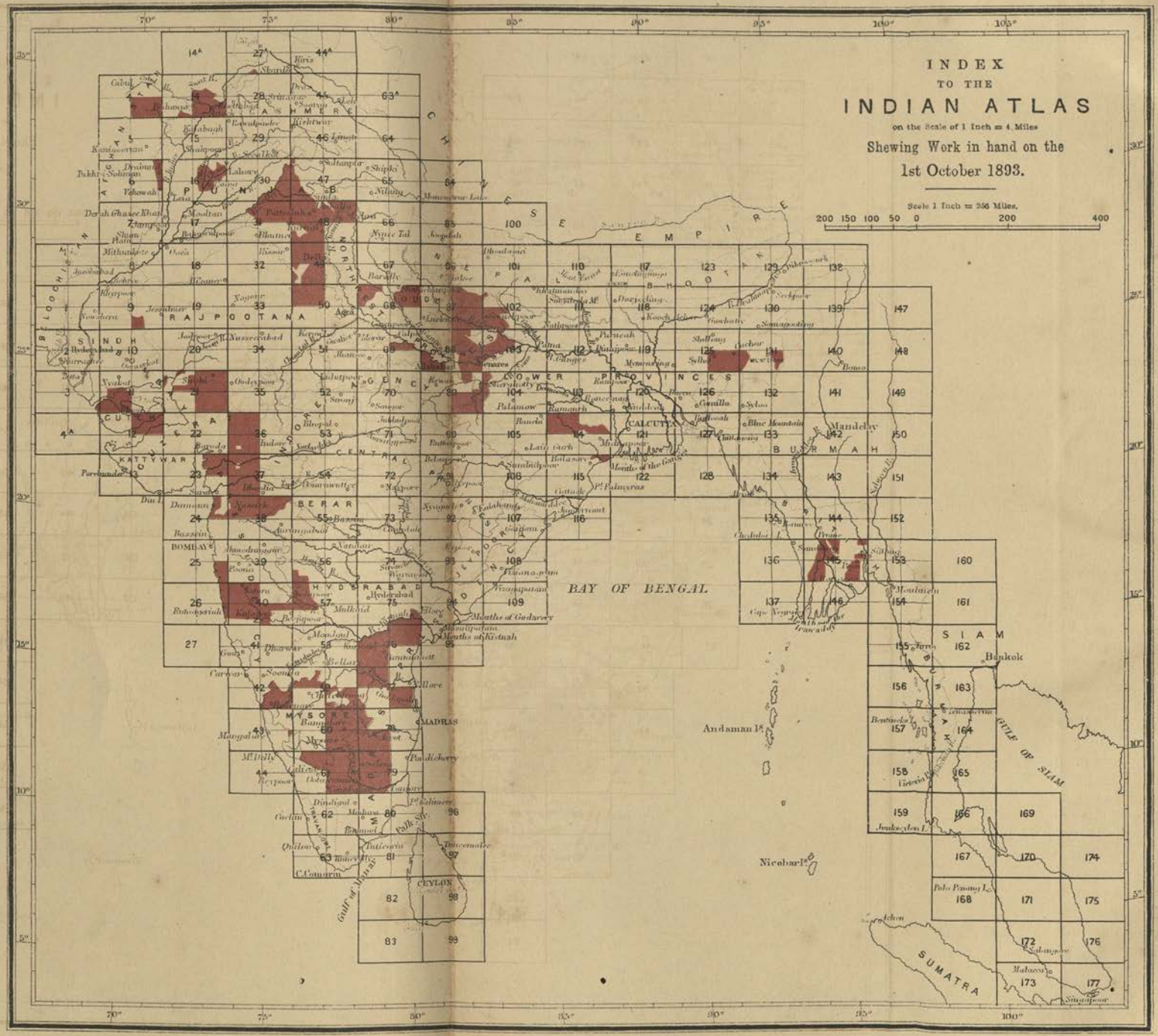
"Mr. Smylie, as Chief Draftsman, has supervised the Office in a satisfactory manner. Mr. Pocock has given great satisfaction as Head Draftsman in charge of the Revenue Section. Mr. James has supervised the Cadastral Section very efficiently. Messrs. Wyatt and Barker have done well in the Examining Section.

"All the European draftsmen have done good service, and among the native establishment, Babus Mohesh Chandra, Purna Chandra Sen, Gopal Chandra Roy and Becharam have received favourable reports."



Reg. No. 767, S. I. D.—Nov. 93.—550.

Litho. S. I. O., Calcutta.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TO THE
INDIAN ATLAS
on the Scale of 1 Inch = 4 Miles
Shewing Work in hand on the
1st October 1893.
Scale 1 Inch = 256 Miles.
200 150 100 50 0 200 400
BAY OF BENGAL
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MYSORE
RAJPOOTANA
SINDH
KATTYWAR
BERAR
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LOWER PROVINCES
BURMAH
GULF OF SIAM
Gulf of Manaar

ENGRAVING OFFICE.

576. The superintendence of this office was held for different periods by several officers during the year. Mr. Fulford has remained throughout in the post of Head Engraver.

Personnel.

Colonel W. H. Wilkins, S.C. Assistant Surveyor General, in charge up to 18th April 1893.
Major R. A. Wahab, R.E., Deputy Superintendent, 1st grade, in charge from 19th April to 9th July 1893.
T. A. Pope, Esq., Deputy Superintendent, 2nd grade, in charge from 10th July to 17th August 1893.
Captain C. F. Close, R.E., Assistant Superintendent, 1st grade, in charge from 18th August 1893.
Mr. J. Fulford, Head Engraver.
„ W. Donaldson, Engraver.
„ S. M. Coard, „
„ T. B. Rodger, „
„ A. W. N. James, „
„ A. R. Coard, „
„ E. C. V. Ollenbach, „
„ E. Earle, „
„ L. H. Musgrove, „
„ F. R. C. Scallan, „
„ W. M. Wells, „
„ A. T. Vieux, „
2 Native engravers.
3 Apprentices.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate Printer.
„ A. E. Pilley, Assistant Copper-plate Printer and Store-keeper.

577. The out-turn of work, a summary of which will be found in the appendix, is about the same as last year, though the number of plates worked on is considerably larger.

578. Four quarter sheets of the Atlas of India and 20 other plates have been engraved and published. The plan of the new survey of Calcutta, on the scale of 16 inches = 1 mile, which will be in 9 plates, has been commenced.

579. The skeleton edition of the 32-mile map of India, in six plates, has been completed as far as possible. The heavy corrections and additions on the duplicate of No 3 plate of the 64-mile map of India have been completed. The plates of the 128-mile map of India, as well as of the 256-mile map are approaching completion. A matrix has been taken from the 96-mile railway map of India, from which all the railways have been removed, so that they can be recut in thin lines on the duplicate. Transfers from this plate will be found useful in the Photo-Litho Office as a guide for printing the railway map in colours.

580. A new plate of the chart of the Great Trigonometrical Survey, on the scale of 1 inch = 96 miles, has been engraved and completed and will be used to illustrate this year's annual report, as the old plate was too much worn to give good impressions.

581. A new map of the Bombay Presidency in one plate, on the scale of 16 miles = 1 inch, has been commenced. A new map also of the Madras Presidency on the same scale, in five plates, has been projected, and dry prints from 3 of the plates have been sent to the Drawing Office for compilation. The maps of Gujarat and the North-Western Provinces and Oudh, on the scale of 16 inches to the mile, have made good progress. The map of the Punjab on the same scale has not yet been published, as the Punjab Government have not returned the proofs which were sent to them for review.

582. The map of Darjeeling, on the scale of 1 inch = 4 miles, as well as 16 district maps for Administration Reports, which were in progress during the previous year, have been completed and published. The indexes to the standard sheets of Assam, Central India, and Rajputana have been completed and published.

583. The Copper-plate Printing Section pulled 30,570 impressions, which is the largest out-turn of work ever accomplished and exceeds that of last year by 11,603 impressions. The new copper-plate printing press for dry printing has worked very satisfactorily, and it is owing to its addition that the increase in the out-turn has been arrived at. The Steel-facing Section dealt with 185 plates.*

* The Assistant Surveyor-General reports as follows:—

"The Head Engraver, Mr. Fulford, has supervised the office in a most efficient manner, and he reports favourably of all his establishment."

CALCUTTA CITY SURVEY OFFICE.

Personnel.

Colonel W. H. Wilkins, S.C., Superintendent, 1st grade, in charge.
Mr. A. J. Wilson, Extra Assistant Superintendent, 1st grade.
Babu Sarat Chunder Sen, Sub-Assistant Superintendent, 3rd grade.
12 draftsmen.
3 field surveyors.

584. This detachment has been under the superintendence of Colonel W. H. Wilkins, Assistant Surveyor-General, throughout the year, Mr. A. J. Wilson being in immediate charge.

585. The following work has been completed during the year under report:—

(1) The original field sheets were brought up to date in respect to new buildings and *bustee* improvement, roads, etc., with the exception of a small portion to the extreme north, which remains for revision. The re-survey of portions of ten sheets was executed, which was necessitated by the construction of the new Harrison Road; all the new properties had to be demarcated. The new buildings, as far as completed, will be shown on the maps before the sheets are sent to press.

(2) Of the 236 fair sheets on which the survey is mapped, 12 were reported last year as having been sent to press; of the remainder, 151 have been finally examined and sent to press. There are still 73 sheets in hand, all of which will be sent to press by the end of February 1894.

(3) The 163 completed sheets comprised 41 full blocks and parts of 20 blocks; of the 41 blocks, 26 were sent to the Municipal Office to be placed on view before final publication under Section 20 of Act I (B. C.) of 1887, and 13 comprising the Maidan, do not require to be sent; of the 26 blocks sent to the Municipal Office, 12 only have been returned after they had been carefully examined in that office. These 12 block maps after having received the approval of His Honour the Lieutenant-Governor of Bengal, which has been notified in the *Calcutta Gazette*, have been published under Act I (B. C.) of 1887, and are ready for sale to the public. It may be summed up briefly that the whole of the sheets of the South Division, including Hastings, the Maidan, and about half the number of the North Division are entirely completed.

(4) It was stated in paragraph 502 of last year's report that in the survey and adjustment of boundaries 864 holdings were remaining for final demarcation. These have been completed during the year.

(5) The claims of 485 disputed boundaries were decided in the Court of the Assistant Superintendent of Survey, Babu Tarini Kumar Ghose, and 29 are under investigation.

(6) The fair copy of the Register of names of proprietors in the South Division is completed and bound in two volumes. The Register of the North Division is in fair progress.

586. The procedure described in paragraph 504 of last year's report for preparing a 16-inch map direct from the original fair sheets by heliogravure was tried but proved unsuccessful and was therefore abandoned. The 16-inch map will now be engraved on copper, in 9 plates, the aid of photography being brought in to supply transfer prints on tracing paper. The copper plates are covered with a thin coating of wax on which the prints are transferred direct and passed through a press: on removing the paper an exact image of the outline is left on the wax for the engravers to work on. The experiments that have been made show that this system will be most successful; and there is every expectation of the 16-inch map of Calcutta being published by the end of 1894.

587. For the reproduction of the sheets on the full scale of survey, sanction has been obtained from the Government of Bengal for the purchase of 236 zinc plates; when the required copies have been printed off, the plates will be preserved in the Survey Office. The present survey can therefore be

brought up to date as alterations occur, and the zinc plates revised whenever a new edition of any sheet is required.*

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

588. The office was under the charge of Colonel J. Waterhouse, Assistant Surveyor-General, until the 12th August 1893, when he proceeded on duty to Poona to inspect the fair drawings of Nos. 10 and 17 Parties, and afterwards went on privilege leave for 1 month and 28 days; during his absence Mr. T. A. Pope officiated for him.

Personnel.

Colonel J. Waterhouse, Assistant Surveyor-General, in charge up to 12th August 1893.

Mr. T. A. Pope, Officiating Assistant Surveyor-General, in charge from 13th August 1893.

LITHOGRAPHIC AND PRINTING DIVISION.

Lithographic Drawing Section.

Mr. H. L. Lepage, Head Assistant.
„ E. Dowling, Head Draftsman.
Babu Ambica Churn Mookerjee, Draftsman.
Munshi Sobhan Buksh, Examiner.
One apprentice and 27 draftsmen and 6 colorists.

Lithographic and Zinc Printing Section.

Mr. B. Mackenzie, Head Printer.
„ D. Deas, Chromo-Litho Printer.
„ S. U. Ravenscroft, Assistant Printer.
„ J. B. Mackenzie, Assistant Printer.
1 machine printer, 1 apprentice, 15 litho. and zinco. printers, 9 machinemen, 17 spongemen, 40 pressmen, 1 paper wetter, two stone grainers, two stone polishers, 4 zinc grainers, 1 ink grinder, 1 engine driver and 1 fireman.

Type Printing Section.

Mr. E. DePyvah, Head Printer, 11 Compositors, 3 type printers, 3 inkmen, 3 mates, 2 machine type printers and 2 machine inkmen.

NORMAL ESTABLISHMENT.

PHOTOGRAPHIC AND GENERAL DIVISION.

Photographic Negative and Printing Section.

Mr. J. Harrold, Photographer.
„ C. J. Meade, Assistant ditto.
„ P. Michael, „ ditto.
„ C. Andrews, „ ditto.
Munshi Ismail Khan „ ditto.
„ Habibul Hossain „ ditto.
Mr. F. U. Murphy „ ditto.
5 Assistant Photographers and 8 laborers.

Heliogravure Section.

Mr. A. W. Turner, Photo Engraver.
„ J. T. Meade, Asst. ditto.
1 apprentice, 1 Assistant Photo Engraver, 1 Engraver, 1 assistant engraver, 4 copperplate printers, 6 pressmen and 11 plate polishers.

Correspondence, Stores and Account Section.

Mr. W. Moore, Storekeeper.
Babu Kanny Lal Sen, Head Clerk and Accountant.
„ Kedar Nath Ghose, clerk.
„ Gopal Chunder Mookerjee, clerk.
6 clerks and 1 paperkeeper.

CADASTRAL ESTABLISHMENT.

Photographic Section.

Mr. H. Haward, Head Photo. Assistant.
„ R. George, Photographer.
„ L. Lagnier, ditto.
„ T. Lloyd, ditto.
8 Assistant-Photographers
10 labourers.

Zinc Printing Section.

Mr. E. A. LeFranc, Zincographer.
„ F. R. Vandyke, ditto.
„ G. A. LeFranc, Asst. ditto.
9 zinc correctors, 9 zinc printers, 10 spongemen, 17 pressmen and 11 zinc grainers.
2 clerks.

589. The reorganisation of the office, which has been referred to in former reports, was sanctioned by the Secretary of State, and took effect from the 8th March 1893. The distribution and full strength of the *personnel* of the establishment under the new organisation are shown in the margin. For convenience, the establishments of the old Lithographic and Photographic Offices have been arranged into two divisions. The "Lithographic and Printing Division," comprising the lithographic drawing, litho and zinc printing and type printing sections, and the "Photographic and General Division," comprising the photographic negative and printing, the heliogravure, and the correspondence, stores and accounts sections. These two divisions form the Normal Establishment, while the Cadastral Establishment remains on the same footing as it was before and forms a third division. This combination of the former three separate establishments into two, very much simplifies the working of the office in the way of correspondence, accounts and returns, and, from the few months' experience of it, seems likely to work satisfactorily, though the thorough amalgamation of the lithographic and zinc printing sections must be a work of time. Further details of the changes in the various sections are given in Colonel Waterhouse's report in the appendix, to which is added a letter showing the causes which led to the necessity for reorganising and increasing the establishment. The principal feature of the reorganisation is the

* Colonel Wilkins reports that Mr. A. J. Wilson has exercised a careful supervision over the office. Babu Sarat Chunder Sen has been very useful in the demarcation.

provision for machine printers and machinemen, enginemen, and firemen for working the lithographic and type-printing and other steam machines. The cost of the various changes and new appointments was met to a great extent by reductions of other posts and transfers, but the net result is an increase of R488-10-8 per mensem, which will be more than repaid by the increased value and quantity of the work turned out. In the present year, the increase in the value of the work done has been R38,493, while the extra cost of establishment has only been R5201-9-5, including exchange compensation allowance.

590. The new establishment and arrangements have greatly facilitated the accomplishment of the large amount of work now thrown on the office. It will be observed that the out-turn of the zincographic and lithographic presses is over a million pulls, of which more than one-fourth is increase during the year. If the demands continue to increase at this rate, further additions to the printing and drawing sections will be absolutely necessary. As it is, the increased requirements for type work, chiefly headings and footnotes, and zinc corrections, have pressed very heavily on the existing establishments and caused delay in publishing.

591. The starting of the new quad-crown lithographic machine in March 1893 has been the means of relieving the strain on the zinc and lithographic printing section, and has enabled the office to meet without difficulty the increasing demands for colour-printing work, so that with the three steam machines a very much larger quantity of work has been turned out than formerly and in very much less time, and, as a rule, the machines are kept running steadily.

592. The general abstract of work turned out is given in the tabular statement below and again shows an unprecedentedly large increase over the previous year in nearly all items.

General Abstract of work done during 1892-93.

Classification.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.								Type Printing.			Silver and other Printing.		Heliogravure and Electrotyping.				Value.
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones printed.	Pulls.	Number of Copies. Coloured.	Uncoloured.	Total.	Pages or items set up.	Pulls.	Copies.	Silver prints.	Blue prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.	
																				R. a. p.
Departmental maps and plans	1,095	1,552	1,367	575	624	118	185,414	26,429	167,080	193,509	11,210	1,418,607	693,668	46	2,165	7	512	...	19	81,128 4 9
Cadastral maps	5,597	4,203	3,993	5,442	5,442	...	162,023	...	151,213	151,213	...	...	...	...	...	...	...	...	...	76,603 15 6
Extra-departmental maps and plans	1,673	1,191	928	475	590	690	679,245	178,693	288,570	662,463	...	...	...	1,223	727	78	60,570	80	...	91,118 1 6
Totals	8,365	6,946	6,278	6,492	6,656	808	1,026,682	200,322	806,863	1,007,185	11,210	1,418,607	693,668	1,269	2,892	85	61,082	80	19	248,850 5 9
Totals of 1891-92	7,532	6,153	5,729	5,867	5,908	579	756,068	129,154	613,103	742,257	8,615	1,318,597	678,968	2,998	2,466	50	42,415	57	14	210,356 10 0
Differences	+ 833	+ 793	+ 549	+ 625	+ 748	+ 229	+ 270,614	+ 71,168	+ 193,760	+ 264,928	+ 2,595	+ 100,010	+ 14,700	— 1,729	+ 426	+ 35	+ 18,667	+ 23	+ 5	+ 38,493 11 9

The out-turn of the lithographic and zinc-printing presses was 1,026,682 pulls, of which 270,614, or considerably more than one-fourth, is increase over last year. This increase alone is about equal to the annual out-turn of the photographic office presses ten years ago. The increased out-turn is chiefly due to additional demands for extra-departmental work, but it is general and distributed through all branches of the office dealing with the departmental and extra-departmental work. Although the number of departmental maps, etc., under reproduction was less by 57, the number of pulls from zinc or stone were 55,170 more, the cadastral pulls were 12,024 more and the extra departmental pulls were no less than 203,400 more than last year. The type-printing also shows a very large increase in the items set up, amounting to about 23 per cent., and the number of pulls or impressions is also larger by about 7 per cent. The silver-printing shows a falling off, but the excess of last year was exceptional; the blue prints, however, show an increase. In the heliogravure section there was a very large increase of work, both in the number of plates etched and in prints, also in photo-blocks and electrotypes.

593. The completion of the new third edition of the 32-mile map of India has again been delayed for further corrections to sheets Nos. 1 and 4; also for

the receipt of final orders regarding boundaries. The last corrections are now in hand, but it is quite uncertain when the map will be published.

594. The general and provincial maps published during the year include a new map of Upper Burma on the 16-mile scale; a second edition of the map of Burma and adjacent countries, on the scales of 1 inch=32 miles and 1 inch=48 miles; Central India Agency, scale 1 inch=16 miles, with corrections to 1891; Assam, 1 inch=16 miles and 1 inch=24 miles, both corrected to 1891; Central Provinces, 1 inch=16 miles, with additions to 1892; Bengal, Behar and Orissa, 1 inch=16 miles with additions and corrections to railways and boundaries to October 1892, also on the scale of 1 inch=32 miles; and His Highness the Nizam's Dominions, including the Assigned Districts of Berar, 1 inch=16 miles, with additions and corrections to December 1891.

595. Among the new divisional maps, on the scale of 1-inch=4 miles, may be noted Fyzabad and Lucknow, while new issues with corrections have been made of Meerut, Agra and Benares. A map of the Orissa division, on the scale of 1 inch=8 miles, has also been published.

596. The following district map, on the scale of 1-inch=4 miles, taken from the engraved atlas sheets, have been printed off during the year, *viz.*, Rajshahi, Burdwan, Birbhum, Bogra, Dinajpur, Balasore, and Purnea.

597. Eighty-nine standard sheets, on the 2-inch, 1-inch, half-inch and quarter-inch scales, were published during the year, including 17 sheets of Assam, 7 of Bengal, 6 of Bombay, 17 of Lower Burma, 1 of Upper Burma, 8 of Central Provinces, 2 of Madras, 2 of North-Western Provinces and Oudh, 11 of the Punjab, 4 of North-East Frontier, all of which are new editions, and 14 sheets of the South-East Frontier Series.

598. Among plans of cities and cantonments may be noted a third edition of the City of Calcutta in 2 sheets, and a re-issue of the plan of Delhi corrected to 1893, both on the 6-inch scale; also a plan of Tounggyi Civil Station on the 10-inch scale.

599. The photo-zincographing of the full-scale sheets of the new survey of Calcutta, on the 50-feet scale, has made good progress, 130 sheets having been reproduced and transferred and 30 printed off. Further trials of various ways of reproducing the reduced map of Calcutta by heliogravure direct from new and generalised drawings were made, but as none of the results were satisfactory, it has been finally determined to engrave the map by hand on the basis of reduced photo transfer prints of each sheet, which are transferred into their places on the copper-plate and the detail cut in by the engraver. This method will give all the accuracy of photography with the superior finish of a hand-engraved map.

600. Among the miscellaneous maps, 41 sheets of the Madras Forest Surveys are the principal item, and 4 sheets of the Aden Survey on the scale of 1 inch=2 miles have been printed. The panoramic profile of the hill ranges seen from Simla, drawn by Colonel Woodthorpe, R.E., was lithographed in colors and has now been printed off. It is a fairly good specimen of chromo-lithography.

601. The extra-departmental work again shows a very large increase, the number of subjects reproduced during the year showing an excess over last year of 249, the pulls of 203,400 and the value of work done of R18,440. The increase has been specially marked in the case of the work reproduced for the Public Works Department, Government of India, and for the Meteorological Reporter, Government of India, the former showing a rise from 27 to 216 in the number of subjects reproduced and from 6,990 to 59,154 in the number of pulls; while the latter shows an increase of 68 subjects and 40,835 pulls. On the other hand, there have been large reductions in other departments.

602. The new geological map, on the scale of 1 inch = 96 miles, noticed in the last report, was printed off. A map of India, also on the scale of 1 inch = 96 miles, showing railway lines and distribution of coal was lithographed for the Reporter on Economic Products. A new edition of the Forest Reserve map of India, on the scale of 1 inch = 48 miles, was lithographed and printed in colors. A series of 3 maps illustrating the Mutiny in 1857 were printed off for Mr. G. W. Forrest's work on the Indian Mutiny. Among these, a map of the British position before Delhi, photo-zincographed in colors, is specially noticeable. Maps of the Fyzabad and Benares Divisions for the North-Western Provinces Government were completed. Several maps illustrating the census

reports for Bengal, Central Provinces, Rajputana and Berar have been printed, also four for the revised edition of Aitchison's Treaties. A large number of maps of grass *rukhs* were drawn and printed for the Quarter Master General. The printing off of further copies of the maps for the Leprosy Commission Report, of a large number of plates of girder bridges and arched culverts, and of plates connected with the Report of the Committee of Locomotive and Carriage Superintendents, for the Railway Department, as well as the usual meteorological charts for India and Bengal, and the maps for the Bengal Administration Report have kept the machines in full work during the year. Thirty-one plates illustrating the Report on the Archæological Remains in the Kistna district have been photozincographed and printed off. Two heliogravure plates for the same report were prepared, but had not been printed off at the end of the year. A similar series of over one hundred plates illustrating Mr. Smith's Report on the Architectural Remains of Fatehpur Sikri is in hand.

603. As noted above, the work of the heliogravure section has very largely increased. By the photo-etching process 85 plates have been produced and 61,082 copies printed off during the year, showing an increase of 35 in the number of plates and 18,667 in the number of copies. A specimen of the work done by this process is given as a frontispiece to this report, being a reproduction of a negative by Major Gore, R.E., representing the Shainsar temple in Kulu. Eighty photo-blocks have been prepared, chiefly for the illustration of Mr. Cotes' papers on Economic Entomology, and 19 plates have been electrotyped.

The method of correcting engraved copper plates by electro-deposition, which was fully described in the Annual Report for 1872-73, has been tried again and three plates have been corrected in this manner, as described in the appendix. The best way of carrying out the process practically is not yet settled, but from the results obtained there is no doubt that it could be successfully worked and would prove a very useful method of correcting engraved plates with less damage to the surrounding work than is the case with the ordinary method. Two plates of the Technical Art Series, 1892, and 12 for 1893, were printed off during the year. The reproduction of the Bower Manuscript, referred to in former reports, has gone on steadily, 21 plates were etched and 18 printed off during the year. The plates for the second part were well advanced at the end of the year under report and have since been completed. Four plates of Malacostraceous Crustacea were etched and printed off for the Indian Museum, and seven plates from photographs by Captain Bower illustrating his travels in Tibet. Two plates of antiquities in the Kistna district were etched, but not printed.

A trial was made of reproducing in colors, maps with hills shaded by brush, but it was not very successful, owing to the difficulty in getting good brush-shaded originals. A second trial has been made by drawing the hills on glass by hand and using the drawing as a transparency for etching. The results are given in the accompanying plate and the method appears likely to be useful in many cases. The drawing of the hills on the glass is quite easy for a lithographic draftsman, while the result of printing from a copper-plate is much better than can be obtained from the stone.

604. In August Colonel Waterhouse was deputed to Poona to inspect the fair maps of Nos. 10 and 17 Parties, and he took the opportunity of visiting the Government Photo-zinco Office.*

* Colonel Waterhouse again reports very favourably of all his principal assistants, to whose exertions are chiefly due the successful carrying out of the largely increased demands upon the office, *viz.*, Messrs. H. L. Lepage, B. Mackenzie, D. Deas, E. A. LeFranc, Sergeant Vandyke and Mr. E. DePyvah in the Lithographic, Zincographic and Type-Printing Sections; Messrs. H. Haward, A. W. Turner, J. Harrold, R. George and L. Lagnier in the Photographic Section; also Mr. W. Moore, Storekeeper. The following junior assistants and apprentices have worked well:—Messrs. J. Mackenzie, G. A. LeFranc, S. U. Ravenscroft, C. J. Meade, J. T. Meade, P. Michael, C. Andrews, F. U. Murphy, C. L. Green, and N. J Gonsalves. In the Lithographic Drawing Section, Babu Umbica Churn Mukerji and Munshis Abdul Hamid, Abdool Hakim and Babu Dina Nath Das may be specially noticed among the native draftsmen, but they have all generally worked well. Among the native assistants in the Photographic Sections, Mahomed Ismail, Habibul Hossain, Abdul Ruhman, Umbica Churn Bhuttacharji and Preo Nath Chatterji, assistant photographers, Azizur Ruhman, native engraver, and Aghore Nath Sircar, copper-plate printer, have worked very satisfactorily. In the Correspondence and Account Sections, Babu Kanai Lall Sen, the Head Clerk and Accountant, deserves special mention for his zeal in carrying on the greatly increased work of the office; Babus Gopal Chunder Mukerji, Nogendra Nath Mukerji, Kedar Nath Ghose, Rajani Kanta Chatterji, and Surji Kumar Banerji have also done their work well.

SPECIMEN OF PHOTO-ETCHING PRINTED IN THREE COLOURS.

Taken from the Survey of the Andaman Islands Seasons 1883-86

Photo-etching, Survey of India Offices, Calcutta, December 1893.

Note: Hills drawn on ground glass with black chalk.

MAP RECORD AND ISSUE OFFICE.

Personnel.

Colonel W. H. Wilkins, S. C., Assistant Surveyor-General, in charge up to 30th November 1892.
Major R. A. Wahab, R. E., Officiating Assistant Surveyor-General, in charge from 1st December 1892 to 9th July 1893.
Mr. T. A. Pope, Officiating Assistant Surveyor-General, in charge from 10th to 17th July 1893.
Captain C. F. Close, R. E., Officiating Assistant Surveyor-General, in charge from 18th July 1893.
Mr. A. E. Byrn, Head Assistant, up to 30th November 1892. Retired.
Mr. F. A. D'Rozario, Head Clerk, from 1st December 1893.
Mr. H. R. Vallis, Map Curator, and 15 clerks.
Mr. B. M. Wilson, Sub-Assistant Superintendent, 2nd grade, attached, up to 13th August 1893. Retired.

605. During the year under report the general superintendence of this office has been at different times in the hands of Colonel W. H. Wilkins, S.C., Major R. A. Wahab, R. E., Mr. T. A. Pope, and Captain C. F. Close, R.E., respectively.

606. The number and value of maps issued during the year are as follows :—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	1,76,841	56,617
Ditto to India Office, London	4,772	7,015
Ditto to Agents	1,363	2,260
Ditto to private individuals	8,099	22,561
TOTAL	1,91,075	88,453
Cadastral maps to Government officials	1,32,188	62,521
GRAND TOTAL	3,23,263	1,50,974

607. There has been a very considerable increase in the number of maps issued, as well as in their value, as compared with last year's totals, which were 1,90,579 and 1,36,079, respectively. The increase is due almost entirely to larger demands from officials, the supplies to them having exceeded in number that of last year by 1,35,748.

608. The amount realized from cash sales of maps was ₹33,303, *viz.*, ₹22,561 from private individuals, ₹1,289 from Agents, and ₹9,453 from Government officials. Thus the cash receipts exceed that of the preceding year by ₹11,212.

609. In the Revenue section, 839 applications were received for extracts from original records of the Revenue Surveys, and 3,610 certified copies of village plans, tracings, and traverses were supplied at a cost of ₹11,037.

610. The details of work done are given in the following statement, and compare favourably with those of the preceding year :—

Details.	Number.
Applications received for maps	5,878
Letters issued in reply	3,238
Cash and credit map sale bills	1,454
Invoices and receipts issued for published maps	2,047
Ditto ditto for cadastral maps	540
Ditto ditto for extracts from original records	375
Packets, parcels, and local despatches	4,874
Ditto received in the office	835
Packages despatched by rail and steamer	385
Ditto received ditto	61
Maps coloured for sale and issue	27,537
Ditto for other departments	3,974

A list of the maps and charts published during the year will be found at page 115.*

* Major Wahab and Captain Close both report favourably of the services of Mr. D'Rozario. Mr. H. R. Vallis has continued to discharge the duties of Map Curator and Salesman in a very satisfactory manner. Messrs. Hazra and Bellety have given satisfaction. The native establishment is reported to have worked well.

MATHEMATICAL INSTRUMENT OFFICE.

511. During the period under report, the charge of the office and the appointment of Patents Secretary have been held by Lieutenant-Colonel M. W. Rogers, R.E., Assistant Surveyor-General, up to 18th April 1893, when he proceeded on special leave, and from that date to the end of the year by Colonel W. H. Wilkins, S.C., Assistant Surveyor-General. The figures given in this report refer to the financial year 1892-93, *i.e.*, from 1st April 1892 to 31st March 1893.

Personnel.

Lieutenant-Colonel M. W. Rogers, R. E., Assistant Surveyor-General, in charge up to 18th April 1893.
Colonel W. H. Wilkins, S.C., Assistant Surveyor-General, in charge from 19th April 1893.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument Maker.
„ F. Marshall, Assistant Mathematical Instrument Maker, up to 4th July 1893.
205 Artificers.

Store Branch.

Mr. M. C. Belletty, Storekeeper.
Babu Womesh Chunder Chowdhury, Material Storekeeper.
1 packing Sircar and 2 Packers.

Office Establishment.

Mr. W. Campagnac, Head Clerk, from 11th April 1893.
„ W. R. Tulloch, 2nd Clerk, Officiating Head Clerk, from 1st to 10th April 1893.
8 Clerks and 3 temporary clerks.

612. During this year 108,654 serviceable instruments, valued at R2,77,280, were received into store, and 100,827 instruments, valued at R2,97,150, were issued. Compared with the preceding year, this shows an increase in number and a considerable decrease in value in the receipts; whilst the issues were considerably greater in number but somewhat less in value, as shown below:—

	1891-92.	1892-93.	Increase.	Decrease.
Number of instruments received	93,661	108,654	14,993	...
Value of instruments R	3,85,697	2,77,280	...	108,417
Number of instruments issued	83,202	100,827	17,625	...
Value of instruments issued R	3,16,373	2,97,150	...	19,223

The number of serviceable instruments in store has increased by 7,827 and their value decreased by R19,870.

613. The following statement shows the principal sources from which the serviceable instruments were received:—

Sources of Receipts.	Number.	Value.
From England on indent	20,527	1,25,195
By purchase in local market	40,589	41,132
Manufactured in workshop	40,007	40,461
Returned to store by public officers	4,437	7,803
From repairable stock after repair	2,305	6,259
„ other sources	789	430

614. The number of instruments received from England has increased slightly, but their value has considerably decreased. The quantity of instruments derived from this source fluctuates not only according to the demands, but also according to the number which can be repaired and rendered serviceable by the workshop; the latter depends on the requisitions made on the workshop for repairs to instruments sent in specially for that purpose. The number of instruments purchased in the local markets is only slightly increased, but their value is nearly R1,000 greater. The number of instruments manufactured in the workshops is much larger than in the previous year, and their value is slightly increased. The manufactures depend entirely on the number of men who can be spared from the execution of repairs. The class and value of the instruments manufactured will be found in Table C in the appendix.

615. The number of instruments taken from repairable stock and rendered serviceable for issue is less both in quantity and value than in the preceding year, during which the out-turn of this class of work was larger than usual. During the year the office received 3,054 repairable instruments valued at R49,021,

compared with 5,912 instruments, valued at ₹75,365, in the previous year. The total issues from the repairable stock were 2,305 instruments valued at ₹37,243. These were repaired in the workshops at a cost of ₹25,024 and transferred at an enhanced value to the serviceable stock. The repairable stock has thus been increased by 749 instruments, valued at ₹16,787. This increase, although small as compared with the accumulations of ten years ago, shows that the workshop is still unable to cope with the amount of repairable instruments returned to store, and at the same time to meet all the current demands thereon.

616. The conversion of old pattern theodolites and levels alluded to in paragraph 527 of last year's report has been continued, and in the financial year under report 48 levels were made into serviceable instruments and issued, at a total value of ₹11,040. These instruments before conversion were worth practically nothing more than the price of their material. During the year Mr. Bolton, the Mathematical Instrument Maker, has invented a new level which, in addition to being constructed on a sound and ingenious principle, has this advantage, that it is of a pattern into which the old Y levels can be converted, and this class of instruments, which had been lying in the repairable stock practically useless, can now be all utilized and made into serviceable instruments. The Government of India, in recognition of the value of Mr. Bolton's invention, have awarded to him a bonus of ₹2,000, and a further payment of ₹10 per level converted and issued after the first 200. The sanction for the special extra establishment for converting levels granted in 1889 for five years expires on 30th June 1894, and an application has been made to the Government of India to make this grant permanent, as experience has shown that there is practically no limit to the number of levels, etc., which are available for conversion.

617. During the year the number of indents supplied has been less than in the previous year, which was, however, an abnormal one, as mentioned in paragraph 528 of last year's report, there having been a very large number of indents for the new equipment of meteorological observatories. Comparing, however, with past years, there is a steady increase in the number of indents, which have risen from 944 in 1890-91 to 1,244 in 1892-93.

618. There have been no particularly large indents this year, nor any special supplies deserving of mention, but there has been a continual and steady demand for instruments of all kinds. A considerable amount of work is continually being done for the Ordnance Department. The alteration of the service heliotropes, mentioned in paragraph 530 of last year's report, is still in progress, and in addition a number of Watkins' range-finders and Scott's sights have been repaired and adjusted, while the office has been called upon to test a large number of Watkins' clinometers.

619. The payments in cash for charges under ₹50, alluded to in paragraph 531 of last year's report, continue to increase; in April the Public Works Department were required to conform to this rule, and in August the Military Department also. These payments entail a very large amount of extra work and responsibility, and press heavily on the office, and it will inevitably become necessary to increase the clerical staff. However, until the full effect of the cash payments by the two extra departments is known, no proposition for increased establishment will be submitted.

620. Table A (in the appendix) shows the amount of debits against various offices and departments for instruments supplied and for work done. It also exhibits the credits for all instruments and materials returned into store. The value of the issues and repairs executed on book debit was ₹2,87,053, being ₹21,816 less than last year. This amount includes the value of instruments purchased with the extra departmental grant of ₹45,000. The credits for instruments returned into store amounted to ₹57,949, which is considerably less than in either of the last two years. The cash sales were ₹28,186 against ₹23,137 last year, and ₹14,871 in 1890-91, after which year the new rules as to cash payments for supplies under ₹50 commenced. These figures show plainly the great increase in this particular item. The grand total of supplies, including the cash sales, is ₹3,15,239, being a decrease of about ₹17,000 from the last year.

621. The number of principal instruments repaired in the workshop is 2,685, or about 400 more than last year. The total number of instruments of all kinds repaired amounts to 3,642, or almost the same as in 1891-92.

622. It will thus be seen that although the year under review does not show such marked increase in the demands on the office as previous ones, the

general tendency to increase is maintained both for supplies and repairs. The Survey of India still heads the list as the largest customer, having taken instruments valued at ₹73,796; next in order are Bengal (Civil), with over ₹40,000, Burma with nearly ₹40,000, and the Punjab, which took over ₹35,000.

623. During the year the Assistant Mathematical Instrument Maker continued to check the returns of the stock-taking mentioned in paragraph 534 of last year's report; but owing to his death in July last the work remained in abeyance, as, for the rest of the year, there was only one officer to take charge of all the work. It is, however, being continued now, and it is hoped that the final report will soon be submitted. The result of the stock-taking is stated by Colonel Rogers to be satisfactory.

624. The profit and loss account of the workshop will be found in the appendix, the result of the operations showing an apparent profit of ₹306. This indicates that the rates are very nearly what they should be, but in order to produce this satisfactory result, the apparent value of the work done in the workshops has had to be reduced considerably, as compared with last year, which affects the comparisons of the value of work done this year.*

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

625. The work of the office is divided into the following sections:—

(1) Correspondence, Accounts, and Records.
(2) Computing.
(3) Type-printing.
(4) Drawing and compiling.
(5) Photo-zincography.
(6) Solar Photography.
(7) Miscellaneous.

626. The principal work is the final reduction and publication of the operations of the trigonometrical survey, and to the carrying out of this, each of the first five sections mentioned above contributes. The office has to deal with the principal chains of triangulation spread over the whole of India, and the secondary triangulation executed in connection therewith, the astromical observations for the determinations of azimuth and of latitude and electro-telegraphic determinations of the differences of longitude; also with spirit-levelling operations and tidal observations.

Personnel.

Colonel G. Strahan, R.E., Deputy Surveyor-General, in charge Trigonometrical Branch.
Mr. J. Eccles, M.A., Deputy Superintendent, 2nd grade, in charge Computing Party.

(1) Correspondence, Accounts and Records.

Mr. F. A. D'Rozario, Head Clerk, up to 8th November 1892.
Mr. J. Burbridge, Head Clerk, from 1st December 1892.
Babu Hira Singh, Clerk and three other clerks.

(2) Computing.

Mr. H. W. Peychers, Extra Assistant Superintendent, 3rd grade,
Mr. A. Christie, Extra Assistant Superintendent, 3rd grade.
Babu Kali Mohan Ghose, Senior Computer.
Babu Kali Kumar Chatterji, Computer.
Babu Amba Pershad, Computer, and thirty-one other permanent and temporary computers, record and account-keepers, librarian and writer.

(3) Type-printing.

Mr. B. V. Hughes, Printer, 20 compositors and temporary hands.

(4) Drawing and Compiling.

Mr. C. H. McA'Fee, Extra Assistant Superintendent, 4th grade, 5 draftsmen, 1 sub-surveyor, and 12 assistants and apprentice draftsmen.

(5) Photo-zincography.

Mr. S. Manuel, Assistant Zincographer, 2 assistant photographers, 2 draftsmen and 1 map keeper.

(6) Solar Photography.

Mr. C. F. Guthrie, Assistant Solar Photographer.

* Colonel Rogers reports very favourably on the intelligence and ability with which Mr. T. Bolton has performed the duties of Mathematical Instrument Maker throughout the year, during the latter portion of which he was unaided in the performance of his duties, owing to the death in July of Mr. Marshall, the Assistant Mathematical Instrument Maker. This officer was an excellent and hard-working employé, who had acquired the good opinion of the officers under whom he had served, and whose untimely death, caused in a great measure by his devotion to his work, is greatly deplored. The Correspondence and Store Branch under Messrs. Campagnac, Belletty and Tulloch have continued to work satisfactorily, and these officers report favourably of all their subordinates, especially mentioning Babus Durga Churn Ghose, Gossain Das Roy, Shib Chunder Ghose, and Womes Chunder Choudry, material store-keeper.

627. The reduction of the tidal observations is made in the field party office; it is only in the compilation and publication of the results to be embodied in one of the series of professional volumes that this office is concerned. The calculations of observations for latitude, longitude, azimuth, etc., taken by various explorers are also performed in this office, and of late years a good deal of work has been done in this respect, not only in connection with explorations carried out by the Survey Department, but also by officers of other departments

628. The Drawing and Compiling section and the Photo-zincographic section, although existing as auxiliaries to the Computing section, for the publication of maps, charts, etc., required to illustrate the operations of the trigonometrical survey, have besides been engaged with other work; the former with a map of the Isazai expedition and miscellaneous maps, and in assisting the latter with a very considerable amount of work for the Forest Department and for the Quarter Master General's Department.

629. The solar photography has been continued as usual; the work was started in 1877 at the request of the Industry, Science, and Art Department, conveyed through the Secretary of State. At first the pictures were 4 inches in diameter, but later on they were increased to 8 and 12 inches in diameter. The 12-inch pictures are only taken when special features appear.

630. The work of the miscellaneous section is chiefly in looking after the depôt of instruments and stores appertaining to the trigonometrical branch of the survey, and of a special equipment for mobilisation which have now to be maintained on a large scale. It also includes the training of officers and explorers both of this and other departments, and certain scientific investigations which have to be made from time to time.

631. During the year under report the office has completed the printing of Professional Volume XV, which contains the results of the electro-telegraphic differences of longitude in continuation of those published in Volumes IX and X of the same series, as well as the final reduction of all the longitude materials collected up to date, thus completing the scheme within the limits of India proper; the binding of the volume has just been finished, and its issue will shortly be made. Very considerable progress has also been made with the tidal volume; the compilation of the introductory chapters and the letter press and tabular matter for Part II of the volume is nearly completed.

632. The compilation and printing of the synoptical volumes of the several chains of principal triangles, which are required by local officials and detail surveyors, have made very satisfactory progress. Three of the Southern Trigon, five of the South-West Quadrilateral, and one of the North-East Quadrilateral were occupying special attention. Of these, five have been bound and issued; one is nearly completed and will be ready soon for issue; the printing of another is fast nearing completion; the compilation of the press copy of a third volume is very considerably advanced, and its printing is expected to be resumed in the early part of next year. The above will complete the series of synoptical volumes for the Southern Trigon and the South-West Quadrilateral. The volume for the North-East Quadrilateral has been in hand during the latter half of the year, and a little progress has been made with it. The pamphlet of spirit-levelled heights, No. 7 Bombay Presidency, Hyderabad Assigned Districts and Central Provinces, has been bound and issued, and a small catalogue of stars for the epoch, 1st January 1892, from observations by the Great Trigonometrical Survey of India, is in the hands of the binder.

633. In addition to the regular work of the office, two computers were employed for a fortnight for the Quarter Master General's Department in reducing certain astronomical and other observations, and three officers and two Native soldier-surveyors were instructed in exploration work.

634. The work done by the Drawing and Compiling section and by the Photo-zincographic section will be found detailed in the appendix.

635. Photographs of the sun have been taken throughout the year on all days that the sun was visible, and the negatives have been sent to England as usual to the Solar Physics Committee at South Kensington. The information derived from these photographs is included in the yearly volumes of the Greenwich observations.

636. Meteorological observations, including the record of the deep-sunk thermometers, have continued to be taken as heretofore; the sunshine record has also been maintained. The preservation and issue of instruments have been

supervised as usual, and the special mobilisation equipment referred to above kept in an efficient state. One set of examination papers for the Senior Division, and fifteen sets for the Junior Division, were prepared and looked over. Further details of the work done will be found in the appendix.

637. The work of the various sections has progressed satisfactorily. In the Computing section especially it is a matter of congratulation that, owing chiefly to the labours of Mr. Eccles, who has been in charge of it, the greater part of the field records which had been accumulating for many years past have been reduced and published For this purpose a special staff of computers had been engaged as a temporary measure. The forecast of what they would be able to accomplish in the four years for which the sanction for their entertainment was given has been an accurate one; and on or before the first of April next they will be discharged according to the original intention.

638. The Photo-zincographic section has however been unable to cope with the increased demands made on it for the reproduction of maps of the Forest Survey Branch and the issue of these maps has consequently fallen considerably into arrears. This matter has been specially represented to the Government with a view to an enlargement of the Photo-zincographic establishment at Dehra to meet the large increase of work.

639. The offices were inspected by the Surveyor-General in October 1893, who was satisfied with the efficient state of the establishments, and that the out-turn of work was all that could be expected with the means available.*

III.—DRAWING OFFICE, SIMLA.

640. This office has remained under the superintendence of Colonel Holdich during the entire year, although the personal charge of it occasionally devolved upon Mr. G. W. E. Atkinson, when Colonel Holdich was absent at Quetta or in the field supervising the operations of No. 15 Party.

Personnel.

Colonel T. H. Holdich, R.E., Superintendent, 1st grade, in charge.
Mr. G. W. E. Atkinson, Assistant Superintendent, 2nd grade.
„ W. J. Cornelius, Extra Assistant Superintendent, 4th grade.
„ A. Kitchen, Sub-Assistant Superintendent, 1st grade.
„ F. E. Warde, Sub-Assistant Superintendent, 2nd grade.
„ F. Rozario, Surveyor.
„ H. Sindon, Draftsman.
Munshi Jafir Khan, Draftsman.
Mr. W. Manly, Draftsman, and four other draftsmen.

641. The North-West Trans-Frontier and the Northern Trans-Frontier have supplied the office with the principal work of the season—eight standard sheets on the $\frac{1}{4}$-inch and three on the $\frac{1}{8}$-inch scale having been completed. South-West Asia has hardly been touched during the year, although there is a very large accumulation of fresh material which affects nearly all the published sheets. There is still a large reserve of the 8-mile sheets of the North-West Trans-Frontier series to be taken up.

642. Three sheets of the seventh edition of the Turkistan map have been sent in for proof publication only: these sheets have been long delayed pending the consideration of the boundary question. The fourth sheet is still incomplete in the hill-shading, but another month or so should see the conclusion both of Turkistan and of a new edition of Baluchistan of which two sheets have been sent in, and two are very nearly complete. A new map of Afghanistan has been commenced which will not take long, as the Baluchistan material can be largely utilised in it. The map of Persia on the 16-mile scale will next be put in hand, and it will embody as far as possible all the new material which cannot yet be utilised for the revision of the South-West Asia sheets for want of draftsmen.

643. The miscellaneous work of the office has been unusually large. Chief amongst the maps prepared under this head are Captain Bower's route map through Tibet and Lieutenant Swayne's map of the Somali country, in the preparation of which that officer has largely assisted.†

* Mr. Eccles reports very highly of his assistants, making special mention of Messrs. Peychers, McA'Fee, Hughes, Manuel, and Guthrie, who stand at the head of their respective sections; also of Mr. Christie.

He also bears testimony to the good work of the computers, etc.

The Deputy Surveyor-General reports very favourably on the services rendered by Hira Singh, who officiated as Head Clerk for a considerable portion of the year under review.

† With one exception, Colonel Holdich speaks highly of the work done by his assistants. Of Mr. G. W. E. Atkinson he writes:—

"Mr. Atkinson's promotion to the rank of Assistant Superintendent is in every way justified by his unceasing industry in office and his able administration during my absence."

LIST OF MAPS AND CHARTS PUBLISHED DURING THE YEAR 1892-93.

Title.	Scale.	Number of sheets.	Remarks.
Atlas of India.	In. M.		
Sheets Nos. 15, 59, 74, 75, 76, and 116	1=4	6	With additions to 1892.
Sheets Nos. 29 and 30	1=4	2	With additions and corrections to 1892.
Sheet No. 56	1=4	1	With additions to 1882.
Sheets Nos. 68 and 106	1=4	2	With additions and corrections to 1891.
Sheets Nos. 73 and 78	1=4	2	With additions to 1891.
Sheet No. 121	1=4	1	With additions to railways to February 1892.
Sheets, Nos. 4A.N.E.; 43N.E.; 59S.W.; 60S.W.; and 78N.E.	1=4	5	
Sheets Nos. 72N.E.; 91N.E.; 93S.E.; 93S.W.; 125N.W.; 129N.E., and 129S.W.	1=4	7	With additions to 1891.
Sheet No. 87S.E.	1=4	1	With additions to 1886.
Sheet No. 90S.E.	1=4	1	With additions and corrections to 1891.
Sheet No. 124S.E.	1=4	1	With corrections to 1890.
Sheet No. 125S.W.	1=4	1	With additions to 1892.
Sheets No. 130N.E. and 130S.W.	1=4	2	With additions to 1890.
General Maps.			
His Highness the Nizam's Dominions, including the assigned districts of Berar	1=16	2	With additions and corrections to December 1891.
Burma and adjacent countries	1=32	2	2nd edition.
Burma and adjacent countries	1=48	1	
India (with hills)	1=64	4	With additions to railways to January 1893.
India (Skeleton)	1=128	1	With additions and corrections to March 1893.
Provincial Maps.			
Assam—Sheets Nos. 1 and 3	1=8	2	With additions and corrections to boundaries and railways to January 1891.
„ Sheets Nos. 5, 6, and 7 and 8 (in one)	1=8	3	With additions of railways and corrections to boundaries and railways to May 1893.
Assam	1=16	1	With additions and corrections to 1891.
Assam	1=24	1	With additions and corrections to 1891.
Bengal, Behar, Orissa, and Chota Nagpur	1=16	2	With additions and corrections to railways and boundaries to October 1892.
Bengal, Behar, Orissa, and Chota Nagpur	1=32	1	With additions and corrections to 1892.
Central Provinces	1=16	2	With additions to 1892.

Title.	Scale.	Number of sheets.	Remarks.
Provincial Maps—*continued.*	In. M.		
Central India Agency	1=16	2	With additions and corrections to May 1891.
Mysore	1=16	1	
Mysore	1=16	1	With addition of Coorg and railways to August 1893.
Upper Burma	1=16	2	
Divisional Maps.			
Agra (N.-W.-P.)	1=4	2	Corrected to March 1890.
Benares (N.-W. P.)	1=4	2	Brought up to 31st December 1891.
Fyzabad (Oudh)	1=4	4	Corrected to 1st April 1892.
Lucknow (Oudh)	1=4	3	Corrected to 1st April 1891.
Meerut (N.-W. P.)	1=4	3	Corrected to March 1890.
Orissa (Bengal)	1=8	2	
District Maps.			
Backergunge (Bengal)	1=4	1	With additions and corrections to June 1892.
Balasore (Bengal)	1=4	1	With additions and corrections to boundaries, roads, and canals to April 1893.
Birbhum (Bengal)	1=4	1	With additions and corrections to boundaries and roads to November 1892.
Bogra (Bengal)	1=4	1	With additions and corrections to roads, railways, and boundaries to 1892.
Burdwan (Bengal)	1=4	1	With additions and corrections to November 1892.
Darjeeling (Bengal)	1=4	1	
Dinajpur (Bengal)	1=4	1	With additions and corrections to railways and roads to March 1892.
Midnapur (Bengal)	1=4	1	With additions and corrections to January 1893.
Purnea (Bengal)	1=4	1	With additions and corrections to roads, boundaries, and railways to April 1892.
Rajshahi (Bengal)	1=4	1	With additions of roads, and corrections to boundaries and railways to February 1893.
Standard Maps.			
Assam.			
Sheets Nos. 25 and 38	1=1	2	2nd editions.
Sheets Nos. 97, 98, 113, 114, 128, 129, 130, 138, 140, 144, 145 and 146	1=1	12	

Title.	Scale.	Number of Sheets.	Remarks.
STANDARD MAPS—*contd.*			
Assam—contd.	In. M.		
Sheets Nos. 66 and 78	1=2	2	With additions to boundaries to October 1890.
Bengal.			
Sheets Nos. 103, 104, 105, 132, 133, 134, and 361	1=1	7	
Bombay.			
Sheets Nos. 279 S.E. and 309 S.W.	2=1	2	
Sheets Nos. 154, 188, 274 and 304	1=1	4	
Burma (Lower).			
Sheet Nos. 273 $\frac{S.E.}{1}$; 273 $\frac{S.W.}{2}$; 273 $\frac{N.E.}{3}$; 273 $\frac{S.E.}{3}$; 273 $\frac{S.W.}{3}$; 273 $\frac{N.W.}{4}$; and 273 $\frac{S.W.}{4}$	4=1	7	
Sheets No. 143	1=1	1	2nd edition.
Sheets Nos. 144, 189, 190, 226, and 284	1=1	5	
Sheet No. 185	1=1	1	2nd edition.
Sheet No. 186	1=1	1	2nd edition.
Sheet No. 187	1=1	1	2nd edition.
Sheet No. 188	1=1	1	2nd edition.
Sheet No. 233	1=1	1	2nd edition.
Sheet No. 283	1=1	1	2nd edition.
Burma (Upper).			
Sheet No. 264, District Kyaukse	1=1	1	
Central Provinces.			
Sheets Nos. 23 $\frac{S.E.}{2}$; 24 $\frac{S.E.}{2}$; 24 $\frac{N.E.}{3}$; 24 $\frac{N.W.}{3}$; 24 $\frac{N.W.}{4}$; 24 $\frac{S.E.}{4}$; 24 $\frac{S.W.}{4}$; and 25 $\frac{N.W.}{4}$	4=1	8	
Madras.			
Sheets Nos. 150 and 331	1=1	2	
North-Western Provinces and Oudh.			
Sheet No. 185 N.E.	2=1	1	
Sheet No. 161	1=1	1	
Punjab.			
Sheet No. 332 N.W.	2=1	1	
Sheets Nos. 213, 227, 239, 240, 241, 256, 271, 272, 273, and 274	1=1	10	
North-Eastern Frontier.			
Sheet No. 15 S.E.	1=4	1	5th edition.
Sheet No. 23 N.W.	1=4	1	6th edition.
Sheet No. 23 S.W.	1=4	1	7th edition.
Sheet No. 22	1=8	1	4th edition.
South-Eastern Frontier.			
Sheet No. 1 N.W.	1=4	1	3rd edition.
Sheet No. 1 N.E.	1=4	1	5th edition.
Sheet No. 1 S.W.	1=4	1	2nd edition.
Sheet No. 3 N.E.	1=4	1	4th edition.
Sheet No. 4 N.E.	1=4	1	4th edition.
Sheet No. 4 N.W.	1=4	1	5th edition.
Sheet No. 5 N.W.	1=4	1	5th edition.
Sheet No. 5 S.E.	1=4	1	3rd edition.

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps—*contd.*			
South-Eastern Frontier—contd.	In. M.		
Sheet No. 5 S.W.	1=4	1	6th edition.
Sheet No. 5 N.W.	1=4	1	6th edition.
Sheets Nos. 2, 4, and 6	1=8	3	
Plans of Cities and Cantonments.			
Calcutta:—Sheets Nos. M14, M15, N18, N19, N20, O19, O20, O21, P20, Q21, Q22, and R23	105·6=1	12	
Tounggyi Civil Station, Southern Shan States	10=1	1	
Calcutta	6=1	2	3rd edition.
Delhi	6=1	2	Corrected to 1893.
Index Maps.			
Upper and Lower Burma	...	1	
Statistical Maps.			
Railway Map of India, 1890	1=48	4	Corrected to March 1893.
India showing Railways with stations (without hills)	1=64	2	Corrected to 30th June 1892.
India showing Railways	1=96	1	Corrected to 31st March 1893.
India showing Telegraphs	1=96	1	Corrected to 31st 1893.
Administration Report Maps.			
Bahraich	1=8	1	
Balasore	1=8	1	
Palamau	1=8	1	
Miscellaneous.			
Tin Mines in the Maliwun Sub-Division, Mergui District	8=1	1	
Anamalai Reserved Forests, Pollachi Taluk, Coimbatore District, Madras	4=1	10	Preliminary edition.
Alinagaram Reserved Forest, Peryakulam Taluk, Madura District, Madras	4=1	2	
Alagar Hill Reserved Forest, Madura and Melur Taluks, Madura District, Madras	4=1	1	
Alagar Hill Reserved Forest, Madura and Melur Taluks, and Chembulimalai Reserved Forest, Melur Taluk, Madura District, Madras	4=1	1	
Andipati Reserved Forests, Periyakulam Taluk, Madura District, Madras	4=1	2	
Coimbatore Reserved Forest, Coimbatore Taluk and District, Madras	4=1	2	Preliminary edition.
Cumbum Valley, East Reserved Forest, Periyakulam Taluk, Madura District, Madras	4=1	4	
Cumbum Valley, West Reserved Forest, Periyakulam Taluk, Madura District, Madras	4=1	4	
Kanavaipati Reserved Forest, Dindigul and Melur Taluks, Madura District, Madras	4=1	2	
Kanavaipati Reserved Forest, and Perumalai Reserved Forest, Dindigul, Melur and Madura Taluks, Madura District, Madras	4=1	1	
Katampati Reserved Forest, Melur Taluk, Madura District, Madras	4=1	1	
Motamalai, Pudagudimalai and Pulamalai Reserved Forests, Melur Taluk, Madura District, Madras	4=1	1	
Okimuranpuram, Kavalkutiperambu Kataimalai, and Nalankurchi Reserved Forests, Takasi Taluk, Tinnevelly District, Madras	4=1	1	
Palni Hills, Southern Slopes, West Reserved Forest, Periyakulam Taluk, Madura District, Madras	4=1	2	
Palni Hills, Southern Slopes, East Reserved Forest, Periyakulam and Dindigul Taluks, Madura District, Madras	4=1	2	
Perumabinalai Reserved Forests, Melur Taluk, Madura District, Madras	4=	1	
Sirumalai Reserved Forest, Madura Taluk, Madura District, Madras	4=1	1	

Title.	Scale.	Number of Sheets.	Remarks.
MISCELLANEOUS—*contd.*	In. M.		
Valanad Reserved Forest, Tenkarai Taluk, Tinnevelly District, Madras	4=1	1	
Vedakarai Mel, Pidagai Reserved Forest, Tenkasi Taluk, Tinnevelly District Madras	4=1	1	
Wagathumalai Reserved Forest, Madura Taluk, Madura District, Madras	4=1	1	
Isazai Expedition, 1892. Part of Hazara District and Indus Valley	2=1	1	
Aden and neighbouring districts	1=2	4	
Ditto ditto	1=4	1	
Road Map of the Punjab, showing ferries, sarais, dâk bungalows, etc.	1=16	2	
TRIANGULATION CHARTS.			
Part of the Manipur Hills	1=4	1	
Mandalay Series, Seasons 1889 to 1892	1=4	3	Preliminary edition.

APPENDIX.

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

UPPER BURMA TRIANGULATION.

Statement of the outturn of work executed by No. 24 Party during season 1892-93.

Description of Details.	Principal Triangulation.	Secondary Triangulation.
Number of stations newly fixed		15
„ of figures completed	3	16
Length of series in miles completed	70	180
„ „ approximate series in miles in advance	...	...
Area of triangulation in miles	1262	3200
Average triangular error in seconds	0″40	3″5
„ probable error of angles in seconds	0″18	...
Astronomical azzimuth of verification	...	...
Number of principal stations selected in advance	...	...
„ „ station platforms constructed	...	...
„ „ stations placed under official protection	...	...
„ „ stations the elements of which have been computed	7	15
Area embraced by the triangulation to points exterior to main triangulation in square miles	...	2,000
Number of points (fixed by intersection, but not visited)	...	51
„ „ stations and points the heights of which have been determined	7	30
Number of miles of rays and paths cleared	...	...
„ „ preliminary charts of triangulations	1	2
„ „ hill-tops cleared of jungle	...	8

LATITUDE OPERATIONS.

Extract from the Narrative Report of CAPTAIN S. G. BURRARD, R.E., *in charge of No. 22 Party (Astronomical), Season 1892-93.*

The building of the pillars and station marks was done throughout the season by Sub-Assistant Superintendent Aulad Hossein. On this officer rested the responsibility of deciding whether the zenith sector could be transported to the summit of the various hills. At four stations out of the eight, the latitude pillar was built exactly over the trigonometrical survey station: at one station, Sonáda, the trigonometrical station was a tower station, and the latitude pillar was consequently built a short distance off on the prime vertical of the trigonometrical station. At two stations, Samdari and Chiniána, the latitude stations were also placed on the prime vertical of the trigonometrical stations, as in each case the summit of the hill was rocky and precipitous, and Munshi Aulad Hossein deemed it inaccessible for the zenith sector. At all three stations, Sonáda, Samdari, and Chiniána, the prime vertical was laid down by means of azimuth observations, and the latitude pillar was so close to the trigonometrical station that an error of one minute in the observed azimuth would not have caused a difference of o".01 between the latitude of the trigonometrical station and that of the latitude station. At no place, moreover, could there have been an error of one minute in the observed azimuth.

At Guru Sikkar, Munshi Aulad Hossein encountered some difficulty. The ascent from Uria is over 2,000 feet and very steep and precipitous the whole way. I found that the great theodolite had been carried up by a round-about path made for the purpose up the western slopes of the hill. This path was now difficult to identify, and would have required some expenditure to make it passable. Neither Munshi Aulad Hossein nor the villagers even knew of this path's existence. I heard of it by accident from an English gentleman who had accompanied Colonel Strange, and again, many years afterwards, Colonel Rogers, to Guru Sikkar Peak. The only path shown to Munshi Aulad Hossein by the guides was the one that is always used by the pilgrims; and I think he acted wisely in not building the latitude pillar at Guru Sikkar, and thus obliging me to carry the zenith sector to its summit. Aulad Hossein decided that the path could not be rendered sufficiently easy for the sector, and so built the latitude pillar near Uria village, about 1 mile south of Guru Sikkar peak. The point he chose as the latitude station was situated near the centre of a good secondary triangle, with one angle at Guru Sikkar, the second at Kamuna, and the third at Achalgarh. The old trigonometrical station of Achalgarh could not be identified, so a new one was chosen in the vicinity, and its position fixed from the side Guru Sikkar-Kamuna, the mark-stones at both these places being found intact. The position of the latitude station was then laid down from the three points, Guru Sikkar, Kamuna, and Achalgarh.

EMPLOYMENT OF ZENITH SECTOR NO. 1.

The instrument used this season was zenith sector No. 1. It was designed by Colonel Strange, and purchased by the Indian Government in 1871. It is a sister instrument to zenith sector No. 2, but is in many ways superior to the latter. Zenith sector No. 2 arrived in India in 1870, and was used by Colonel Herschel in 1870-71. Colonel Herschel suggested many valuable improvements and additions, which the makers had time to adopt in the construction of zenith sector No. 1.

Zenith sector No. 2 has been used on several occasions in the last twenty years, and has always given uniformly good results. On the other hand, zenith sector No. 1 was only used once, and that occasion was in 1871-72, when Colonel Campbell observed for latitude at eight stations of the Mangalore Meridional Series. At those eight stations the zenith sector exhibited a "(N—S) difference," by which is meant that a difference was found to exist between the results by north and south stars, respectively; the latitude derived from observations by north stars was always given too small, whilst the latitude derived from south stars was always given too large. Now for north stars—

$$\text{Latitude} = \text{declination} - \text{zenith distance},$$

and for south stars—

$$\text{Latitude} = \text{declination} + \text{zenith distance}.$$

It thus became apparent that this instrument, zenith sector No. 1, measured *all* zenith distances too large. Colonel Campbell writes in 1872: "Zenith sector No. 1 measures zenith distances in excess of their true value, and the most superficial examination shows that the error is a function of the zenith distance, being nearly exactly in direct proportion to it." In fact this (N—S) difference was apparently subject to a law: every zenith distance was observed too large, the error in a Z. D. of 10° being twice the error in a Z. D. of 5° and five times the error in a Z. D. of 1°. On account of this (N – S) difference, zenith sector No. 1 has been laid aside for twenty-two years and never used since its first season.

In 1890 a zenith telescope arrived in India, and the method of observing astronomical latitudes was changed from the "sector" method to the "Talcott" method. By the

sector method the absolute Z. D. of a star is observed, and the latitude deduced from the formula—

$$\text{Latitude} = \text{declination} \pm \text{zenith distance.}$$

By the Talcott method the *difference* of Z. D. is observed between a north and south star, and no absolute zenith distance is measured. Thus a pair of stars are chosen, one north and one south, that transit within a few minutes of each other, and that are as nearly as possible the same distance from the zenith. The telescope is set to the mean Z. D. of the pair, and pointed to whichever star of the pair transits first. The star is intersected by the micrometer. The telescope is then revolved on its vertical axis 180° in azimuth, but its setting is not disturbed. It will now be pointing to the second star of the pair: this star is also intersected by the micrometer. The difference of the micrometer readings is equal to the *difference* between the zenith distances of the two stars, and this quantity is all that we have to measure. If d_n, d_s = declinations of the two stars, and z_n, z_s their zenith distances, then the Talcott formula is—

$$\text{Latitude} = \frac{d_n \times d_s}{2} - \frac{z_n - z_s}{2}.$$

We measure $(z_n - z_s)$, but do not require the absolute values of z_n and z_s.

The zenith telescope gave excellent results, and was consequently looked upon as a good instrument. But it became evident that zenith sector No. 1 would also have given excellent results with no (N—S) difference, if it had been worked as a zenith telescope by the Talcott method.

In the formula—

$$\text{Latitude} = \frac{d_n \times d_s}{2} - \frac{z_n - z_s}{2},$$

z_n and z_s would have been observed both too large, but z_n and z_s being nearly equal, the errors in their measurements would also have been equal, and their difference $(z_n - z_s)$ would have remained correct, for the peculiarity of the (N—S) difference was, that errors in equal zenith distances were equal. The state of the case was this then: zenith sector No. 1, a very valuable instrument, was lying discarded, because it showed a (N—S) difference with the sector method, though it clearly would have given excellent results if used with the Talcott method. On the other hand, the new zenith telescope was being constantly used, merely because it gave good results with the Talcott method, though it had never been tried with the sector method: for anything known to the contrary, this new zenith telescope might also exhibit a (N—S) difference, if worked with the sector method. For these reasons I obtained sanction from the Deputy Surveyor-General to be allowed to use the zenith sector No. 1 this season on the Jodhpore Meridional Series, and to work it both with the Talcott and sector method.

After a season's experience with this zenith sector, I am thoroughly of opinion that the (N—S) difference is due to a constant error running throughout the graduation of the limb, and that it in nowise vitiates results.

This season, 1892-93, the same (N—S) difference to the last decimal place has appeared, as was discovered by Colonel Campbell in 1871. As flexure of the telescope tube has at times been suggested as the cause of the phenomenon, I should like to give my reasons for thinking that flexure has nothing to do with it.

The image of a star is seen on the centre wire, when the line joining the star with the centre wire passes through the centre of the object glass. If then the instrument be perfectly adjusted, and the telescope be set at an angle of θ with the vertical, a star of zenith distance θ will be observed on the centre wire, provided the telescopic tube does not suffer from flexure. If however there is flexure of the object end, the object glass will be lower than in its correct position, and the line joining it with the centre wire will make a larger angle than θ with the vertical, though the angle of inclination, as read on the limb, remains unchanged at θ. If instead of the object end it is the eye-end that is suffering from flexure, the centre wire will fall lower than its correct position, and the line joining the centre wire with the centre of the object glass will consequently make an angle *less* than θ, the reading of the limb still remaining θ.

Therefore, if the telescope be permanently set at angle of θ with the vertical, the following cases occur: (*i*) If there is no flexure, the image of stars of zenith distance θ will appear on the centre wire; (*ii*) if there is flexure of the object end, the image of stars of a zenith distance somewhat *greater* than θ will appear on the centre wire; and (*iii*) if there is flexure of the eye-end, the image of stars of a zenith distance somewhat *less* than θ will appear on the centre wire. In other words, if there is flexure of the object end, the observed zenith distance will be *less* than the true zenith distance, whilst if there is flexure of the eye-end, the observed zenith distance will be *greater* than the true zenith distance. Now, in the zenith sector No. 1, the instrument under review, observed zenith distances are always too large, and hence if flexure be the cause of this phenomenon, it must be flexure of the eye-end.

The following considerations led me to abandon the theory of flexure and to seek another cause:—

(*a*) The telescope tube is elliptical in cross-section, and especially designed against flexure.

(*b*) The object end is longer than the eye-end, and is consequently more liable to flexure than the eye-end, but if the (N—S) difference be due to flexure, it must be flexure of the eye-end.

(*c*) As pointed out by Colonel Campbell, the (N—S) difference is clearly subject to a law, and varies accurately with the amount of the zenith distance. I cannot conceive a telescope, that waves from side to side after the manner of a fishing-rod, obeying any such law. The amount of flexure would not only depend on the zenith distance, but on the direction of motion, with which the telescope was brought up into position, and on the rapidity of this motion.

(*d*) After lying in its box, discarded as useless for twenty-two years, it is tried again, and in 1893 the (N—S) difference in its ratio to the zenith distance is precisely the same as it was in 1871. Can the bending properties of any metal act so accurately, and remain so constant?

Now, in one of the astronomical circles there was also a large (N—S) difference, but in this instrument zenith distances were measured in *defect* of the truth, as would be the case if there were flexure of the object end: moreover the amount of the error was subject to no traceable law whatever, and it was but reasonable to attribute the (N—S) difference to flexure.

I believe now that the (N—S) difference in zenith sector No. 1 is due to error of limb graduation. Zenith distances are all measured too large, and this is exactly what would occur *if the graduations of the limb of the vertical circle were all too small for the radius of the limb.* The amount of the (N—S) difference is such that an angle of 10° is measured on the vertical circle as 10° 0′ 1·″80. The effect on resulting values of latitude may be found thus: suppose a north star and a south star are both observed for latitude, both having a zenith distance of 10°. In both cases their zenith distance, as observed, will be 10° 0′ 1·″80.

In the case of the north star: latitude = declination − Z. D., and the resulting latitude will be 1·″80 too small. In the case of the south star: latitude = declination + Z. D.; and resulting latitude will be 1·″80 too large.

The two values of latitude by the two stars will thus differ by 3·″60: in the ordinary astronomical latitudes, as observed in India, it is quite common for results from forty stars (each observed four times) to all fall within a range of two seconds of arc, and differences of 3·″6 are quite inadmissible: if moreover the two stars in the above example had each had a Z. D. of 15° instead of 10°, the difference between their resulting values of latitude would be 5·″4.

Now, the limb of the zenith sector is not a complete vertical circle, but consists of two segments of 50° each, struck, or intended to have been struck, with a radius of 18 inches.

The surface of the limb is, moreover, not in the plane of the circle of the limb: the sectors are "dished," and meet at an angle at their junction at the horizontal axis: the silver limb has been let into a grove cut on the face of the brass sectors: the surface of the limb is such that if it were produced inwards, it would form not a circle but a cone with its apex at the horizontal axis. It seems apparent that the artificers' difficulties in centering and graduating such segmental arcs, and in placing them in their proper positions relatively to one another, must be greater than in the case of a theodolite with a complete plane horizontal circle. Yet in many of our best theodolites periodic errors amounting to 1·″8 in 10° have been found.

Now, suppose the graduations of the two arcs of 55° have all been made at too small intervals from one another, and that on each arc the graduations for the whole 55° have been distributed through an angular space of only 54°59′50·″1. In the zenith sector this error cannot be compensated, as the limb is not complete: in the horizontal circle of a theodolite it would be compensated. In this latter case, the whole circle must be eventually divided into 360 degrees, so that if the graduations are placed too near together at one part of the limb, they must be too far apart at another, and if the well-known method of changing zero be followed, angles measured with such a circle are unaffected by these periodic errors.

But with the zenith sector there is not only no means of changing zero, but the compensating portion of the limb is altogether absent: so that if there is any error in limb graduation, whether periodic or not, it cannot be got rid of.

Supposing the (N—S) difference to be due to graduation error, the amount of the artificer's error may be arrived at thus: the radius of the limb should have been 18 inches, so that the length of an arc of 10° measured along the limb *should* be 3·1416 inches: but by observation we have found that an angle of 10° at the centre is subtended at the limb by graduations of 10° 0′ 1·″8. This can have resulted in two ways: either the limb has been *graduated* with a radius of 17·9991 inches and then placed on the sectors with a radius of 18 inches, or else the graduations must have been made with a correct radius of 18 inches, but the limb through some miscalculation was shrunk on to the sectors with a radius of 18·0009 inches. One fact is clear, *viz.*, that *the radius of the limb is 0·0009 inch too large for its graduations.*

Suppose the two arcs of 55° are each produced circularly into arcs of 180°, the graduations being made at the same intervals as at present. Then, when the graduations have been extended to 180°, each arc of 180° will only subtend at the centre an angle of

179° 59′ 27″·6. At each of the two points of junction the final graduations instead of being coincident, as they ought to be, will be apart by 0·00282744 of an inch, the length on the limb that subtends an angle of 32″·4.

The amount of the error of graduation has been found as follows:—

In Colonel Campbell's observations at eight stations, his mean Z. D. was 5° 54′ 30″, and his mean (N—S) difference was 2″·125: that is, his final value of latitude deduced from north stars of a mean Z. D. of 5° 54′ 30″ was smaller by 2″·125 than his final value of latitude deduced from south stars of a mean Z. D. of 5° 54′ 30″: thus both his north and south zenith distances (of 5° 54′ 30″) were each measured too large by $\frac{2''\cdot125}{2}$. Colonel Campbell's observations thus give the error of the limb graduation to be 1″·063 in 5° 54′ 30″, from which the following corrections can be deduced: (*i*) An angle of one degree is shown by the graduations on the limb as 1° 0′ 0″·18; (*ii*) an angle of 0° 1′ 0″·00 is graduated on the limb as 0° 1′ 0″·003; (*iii*) an angle of 1″ is shown on the limb as 0° 0′ 1″·00005.

From my observations this season, the (N—S) difference is given at 2″·50 for a mean Z. D. of 6° 39′: from these data the amount of limb error is given as 0″·186 for each degree, 0″·0031 for each minute, and 0″·000052 for each second.

Colonel Campbell's results have been used to deduce a "limb correction," and every *observed* zenith distance has been decreased by 0″·18 for each degree, 0″·003 for each minute, and 0″·00005 for each second. This correction has been applied to all observations taken this season by the sector method, and has brought them into excellent accordance, entirely eliminating all signs of a (N—S) equation.

Final Results.

The final results of the season's work have been abstracted, and are shown in the following table:—

Stations.	Number of stars.	Number of observations.	Astronomical latitude $=\phi$.	Geodetic latitude $=\lambda$.	$\phi-\lambda$.
Sonada . . .	64	192	23° 7′ 15″·64±0″·088	23° 7′ 19″·89	−4″·25
Chuniána . . .	84	168	24° 6′ 25″·45±0″·039	24° 6′ 36″·64	−11″·19
Deesa . . .	55	220	24° 15′ 21″·18±0″·049	24° 15′ 29″·35	−8″·17
Guru Sikkar . .	76	236	24° 37′ 47″·80±0″·036	24° 37′ 50″·96	−3″·16
Samdari . . .	60	240	25° 48′ 59″·61±0″·041	25° 48′ 59″·55	+0″·06
Thob	58	174	26° 3′ 2″·94±0″·046	26° 3′ 5″·85	−2″·91
Chamu . . .	52	156	26° 39′ 53″·49±0″·048	26° 39′ 52″·74	+0″·75
Jambo . . .	58	174	27° 16′ 31″·99±0″·037	27° 16′ 28″·88	+3″·11

At three stations the astronomical latitude was determined both by the sector method and the Talcott method with the following results:—

Stations.	Sector method.		Talcott method.		Differences.
	Number of observations.	Latitude.	Number of observations.	Latitude.	
Chiniána	84	24° 6′25″·44±0″·068	84	24° 6′25″·47±0″·045	−0″·03
Deesa	20	24°15′21″·15±0″·128	200	24°15′21″·18±0″·049	−0″·03
Guru Sikkar . . .	118	24°37′47″·77±0″·049	118	24°37′47″·83±0″·067	−0″·06

The finally adopted values of latitude for these three stations have been obtained from the above separate values by means of combination weights.

The results of the season's work have been also abstracted and classified under different heads with the following results:—

(*a*) In observations taken with the Talcott method, the resulting latitude does not vary at all with any increase in the Z. D. of the pair; pairs of stars of 20° or 30° Z. D. give just as good results as pairs of 5° Z. D.

(*b*) The position of the azimuthal stud is immaterial: it is the practice to reverse the instrument at each station after three nights' work, the first three nights being taken with the azimuthal stud south, the last three with stud north: but this reversal has no apparent effect either in sector or Talcott observations.

(*c*) The results have also been abstracted according to the telescopic position at the observation of the first star of of the pair. It is found that if a pair of stars be observed, the first being taken telescope E. and the second telescope W., the resulting latitude will be less by 0″·30 than would have been the case if the first star of the pair had been observed telescope W. and the second telescope E. This difference has been always found to exist, whether

observations are taken with the sector or Talcott method: it varies with different observers, and is supposed to be due to constant personal error in intersection.

With Talcott's method the difference of zenith distance is measured merely by the eye-piece micrometer: this difference frequently amounts to 8,000 divisions of the micrometer, and consequently the determination of the value of one micrometric division is a matter of more importance, and requires greater nicety than is the case with sector observations, where the micrometer is merely used for the final intersection. In Talcott's formula the "difference of Z. D." has occasionally to be *added* and occasionally *subtracted* from the mean of the declinations, according to whether the north star of the pair has a greater or less Z. D. than the south star: the micrometric measurement of the difference in Z. D. has consequently a positive or negative sign according to which star of the pair has the greater zenith distance: if, then, there was an error in the determined value of one division of the micrometric screw, so that this value was taken too large, this error would tend to make all latitudes too large, when the micrometer correction was positive, and all latitudes too small, when the micrometer correction was negative; if, on the other hand, the determined value of the micrometer correction was too small, resulting latitudes would be given too small when the micrometer correction was positive, and too large when it was negative.

000. As a test of the correctness of the value of my micrometer screw, I have abstracted in the following table the mean value of latitude for each station, derived from observations, in which the micrometer correction was positive, and also the mean value of latitude for each station, derived from observations, in which the micrometer correction was negative. If both these mean values agreed, it would be sufficient proof that there was no error in the adopted value of the micrometer, and from this difference the amount of any error may be determined.

Stations.	Micrometer correction, positive.		Micrometer correction, negative.		Difference in mean value of resulting latitude.	Apparent error in adopted value of micrometer screw.
	Mean magnitude of micrometer correction.	Seconds of latitude.	Mean magnitude of micrometer correction.	Seconds of latitude.		
Sonada	+3,207	15″86	−2,733	15″19	+0″67	+0″000113 too large.
Chiniána	+2,847	25″45	−2,603	25″49	−0″04	−0″000007 too small.
Deesa	+2,718	21″61	−2,329	21″04	+0″57	+0″000113 too large.
Guru Sikkar	+2,335	47″89	−3,151	47″48	+0″41	+0″000075 too large.
Samdari	+2,162	59″77	−2,452	59″43	+0″34	+0″000073 too large.
Thob	+2,975	3″18	−3,180	2″70	+0″48	+0″000078 too large.
Chamu	+2,335	53″49	−3 624	53″50	−0″01	−0″000002 too small.
Jambo	+4,703	32″07	−3,554	31″94	+0″13	+0″000018 too large.

Discrepancies must be expected in the above values of the "apparent error" of the micrometer screw: it is clear that this error, whatever it be, is a very minute quantity, and considerably less than errors of star's place or of observation. Moreover, the number of stars at any station, in which the micrometer correction is positive, is not necessarily equal to the number in which this correction is negative; so that at some stations the "seconds of latitude" given above, either for a positive or negative correction, may possibly be dependent on very few stars—a fact that explains why the "final value of latitude" is not the exact arithmetic mean of the 3rd and 5th columns in the table above. The sign of the micrometer correction, whether positive or negative, depends on *which* star of the pair (*i.e.*, the north or the south) has the greater zenith distance: it is impossible to so arrange a programme of work that an equal number of positive and negative micrometer corrections should ensue: already there are so many conditions attaching to the selection of stars that it is no easy matter to arrange a suitable programme, and this extra condition could not be complied with.

In the above table the "apparent error" of the micrometer screw is given for eight stations, and the mean of these eight results is probably very near the truth, at some stations positive micrometer corrections having predominated, at others negative. The mean result is that the adopted value of one division of the micrometer screw (*viz.*, 1 division = 0″425456) is 0″000058 too large.

Now, this value, 1 division = 0″425456, was determined by means of a collimator in comparison with the limb of the sector. But there are now good grounds for believing that 1″0005 on the sector is equal to one true second of arc—a consideration which would make the value of the micrometer as determined too large by 0″000021.

All that can be said then is, that the theory of a periodic error existing in the limb would render the value of the micrometer too large by some small amount in the 5th place of decimals, and that just such an error, carrying the expected sign, has been discovered. I recommend that the micrometer value in future be taken at 0″425400: the 5th place of decimals has to be considered, as this value is occasionally multiplied by 8,000, and frequently by 5,000, (divisions) in Talcott observations.

The principle of Talcott's method is to observe the *difference* of zenith distance of a pair of stars, one star being observed in *one* telescopic position, the other in the other. The maximum difference of Z. D., which it is possible to measure, depends upon the field of view, for both stars of the pair must be visible without moving the telescope in altitude. In zenith sector No. 1, it is possible to measure about one degree with the micrometer without moving the telescope: thus, if there were one north star with a Z. D. of 10°, and one south star with a Z. D. of 11°, I should set the telescope to 10°30′ with the setting circle; I should then intersect the north star, which would be near one limit of the field view, and then revolve the telescope 180° in azimuth (without altering its setting) and intersect the south star, which would be near the other limit of the field view: the micrometer would have had to be turned through the whole length of its screw, and the difference between its readings would be the difference of Z. D. required.

I have explained the method so far that I may be able to describe a modification which I introduced. The modification consisted in observing two north (or two south) stars for a pair, instead of one north and one south. This can only be done when the mean Z. D. of the two north stars is less than half a degree; but it happened at all my stations that four or five chances occurred of observing pairs of north stars, which were good well-placed stars, and which otherwise could not have been observed at all. Thus, suppose there are two north stars, one with a Z. D. of 0° 10′, and the other with a Z. D. of 0° 30′, I set the telescope to read 0°10′ north, and intersect the star with a Z. D. of 0° 30′ when the telescope is pointing 0° 10′ north, thus giving a run of 20′ to be measured on the micrometer. I then revolve the telescope 180° in azimuth, so that it is now pointing 0° 10′ south; and, with the telescope in this position, I intersect the star that has a Z. D. 0° 10′ north, which also gives the micrometer a run of 20′. This modification is in nowise contrary to any of the Talcott's principles, as the *two* stars of the pair are observed in *different* telescopic positions: the only objection that could be raised has to do with the cancelment of refraction, and errors due to refraction are rejectaneous so near the zenith.

I carried this modification one step further, and introduced the plan of observing *one* star by Talcott's method instead of the usual pair. This can only be done with stars within half a degree of the zenith, of which I generally could get four or five per station. As an example, take a star of Z. D. 0° 20′: in these cases the telescope is set to 0°0′ exactly. The star is intersected in one telescopic position with the micrometer: the telescopic is then revolved 180° in azimuth, and the star again intersected in the other telescopic position; the two intersections and the revolving of the telescope in azimuth have to be all done during the transit of the sta across the field of view: a star takes 40 seconds to transit the field, and 35 seconds is ample to complete the whole observation in. The star in these cases is not intersected exactly on the meridian, and a small correction to the zenith distance has consequently to be applied on this account.

Suppose, in this example, the first micrometer reading=a, and the second micrometer reading=b, then the Z. D. of the star=$\frac{a-b}{2}$, and if δ=declination, the latitude is equal to $\delta \pm \left(\frac{a-b}{2}\right)$ for $\frac{\text{South}}{\text{North}}$ stars. This method gave good results.

Extract from the narrative report of LIEUTENANT G. P. LENOX-CONYNGHAM, R. E., *in charge No. 23 Party (Astronomical), Season 1892-93.*

Before starting from Dehra, I received instructions to take observations for latitude at Rajpur, at a point as near as possible to the foot of the hills, and also at the east end of the Dehra Dun base-line. The object of these observations was to ascertain whether there was any appreciable difference in the apparent local attraction at these two places, the one close to the foot of the hills, and the other about 10 miles from them.

I accordingly selected a suitable station at Rajpur on a piece of level ground, close to a ruined bungalow, known as Seale's Koti, just to the east of the top of the bazar. There was no conveniently situated station of the Trigonometrical Survey, but the point chosen was easily connected by means of a single triangle.

At the east end of the Dehra base-line I observed from a point on the prime vertical of the mark and 23 feet west of it. The platform over the mark was not suitable for the observatory tent.

A much smaller number of stars than usual was observed at each of these two stations, as the results were not required with the same degree of accuracy as at the regular stations of series. The probable errors, however, are sufficiently good for the purpose in view. The change in the difference between the astronomical and geodetic values of the latitude on moving from Rajpur to the Dehra base is surprisingly large, *viz.*, 17″, the difference being at the former station 47″ and at the latter 30″.

Throughout this season I used three programmes of stars, observing each twice, the procedure having been indicated, by the first season of work with the zenith telescope, as the most likely to give good results. My system was to divide the night of 10 hours into three nearly equal portions, and to observe as many pairs as possible in each: this gave from 45 to 65 pairs per station.

The trigonometrical station of Dhauleshwar is actually on the top of a temple, but, as this position was unsuitable for my work, the pillar was built a few feet to the west. The valley to the north of the range on which the station is situated is much lower than that to

the south, the difference being as much probably as 500 feet; the total height of the hill above the plain to the north is about 1,100 feet and to the south 600 feet. In consequence of this some slight deviation southwards may possibly be expected. The weather here was somewhat cloudy, and the work was consequently delayed for two or three days, but eventually a very fairly complete set of observations, consisting of 59 pairs, was obtained.

The station of Kanheri is just within the boundary of Hyderabad territory, on the edge of a plateau which rises rather abruptly from the plains on the western and northern sides and stretches to the east, gradually losing its elevation. The general direction of the ridge on which Kanheri stands is fairly straight from north-west to south-east, and its height above the plain to the south-west is about 800 feet. A very high wind blew from the north-north-east every day from about midnight to mid-day, gradually lessening to a calm at sunset and increasing again until it was a perfect hurricane at 3 or 4 in the morning. The position of the camp, and especially of the observatory, was very exposed, so much so that it was almost impossible to observe the third programme of stars—2 to 5 A.M. The lamps were constantly being extinguished, and had the wind veered a point or two so as to blow directly into the slit, I should have had great fears for the safety of the instrument. Had there been any available ground, in a more sheltered position, I should certainly have had a new pillar built, and so have avoided the wind, but there was no level space except at the summit, so I had to adhere to the original station.

The march from Nitali to Achola, my last station, was much the most interesting I had had. The road ran through Owsa and Nilunga, both *tahsil* head-quarters, and intermediately through a place called Kharosa. This village lies in the valley between two low ranges of hills entirely composed of laterite, and in the more easterly range of the two on the side overlooking the village there are a number of very interesting caves. There are two large halls, the roofs of which are supported by rows of columns about 14 feet high; and arranged on both sides are a number of cells, which look as if they had been used as dwelling-places. This points to a Buddhist origin, but the carvings in the larger of the two halls are evidently Hindu: these carvings cover all the walls of this hall and are most powerful and life-like, and when it is considered how difficult a rock to work laterite must be, it will be admitted that the sculptor was a man of no mean skill.

At Owsa also a most elaborate Hindu temple was in course of construction, and it is evident that capital stone and wood carvers are still to be found in this part of the country. My last camp before reaching Achola was at a place called Dunnágaon, and here a most unpleasant incident occurred, the camp being attacked by hornets—at least I believe from their size that they must have been hornets. The attack took place at about 10 o'clock, just as the men were beginning to cook their food, and we were all prisoners, I in my tent, and the men under their blankets on the ground, until about 5 o'clock, when the fury of our assailants abated. Most fortunately the bullocks were not touched, so that there were no serious consequences. One or two of the men were rather badly stung, but they very soon recovered.

The crossing of the Manjera river was a matter of considerable difficulty. Although I had struck the main route from Hyderabad to Aurangabad, yet the only means of crossing the river was one boat—if the name can be applied to it—which consisted of a large round basket 12 feet in diameter and about 3 feet deep, covered on the outside with leather. Perhaps "coracle" is the nearest English equivalent, but even a coracle has some difference between bow and stern. The carrying capabilities of this boat were very considerable; I should say that 40 men could go in it at once. The greatest drawback to it was the total impossibility of steering it. The current of the river was rapid, and in crossing the boat was carried down stream about 300 yards, and had then to be slowly and painfully towed up that distance before attempting the return journey. The time taken by one complete trip, from the commencement of the loading until the return of the empty boat ready to be loaded again, was from one to two hours, and it was only by the greatest exertion that the crossing of the party was managed in one day. It was long after dark when the camping-ground was finally reached.

The following table shows the final results, the number of pairs of stars from which each was deduced, the probable error, the geodetic value of the latitude, and the difference between astronomical and geodetic values:—

Stations.	Astronomic latitude. $= \phi$	p. e.	No. of pairs.	Geodetic latitude. $= \lambda$	$\phi - \lambda$	Direction of apparent local attraction.
Rajpur . . .	30°-23′-9″·33	·108	10	30°-23′-56″·67	—47″·34	N
E. end Dehra base . .	30-16-37·29	·082	19	30-17-7·35	—30·00	N
Colaba . . .	18-53-39·16	·061	39	18-53-49·49	—10·33	N
Mándvi . . .	18-37-48·09	·054	53	18-37-51·11	— 3·02	N
Dhauleshwar . . .	18-25-42·91	·046	57	18-25-41·64	+ 1·27	S
Khánpisura . . .	18-45-22·57	·054	57	18-45-30·65	— 8·08	N
Kanheri . . .	18-29-21·94	·048	61	18-29-30·75	— 8·81	N
Nitali . . .	18-17-2·80	·051	61	18-17-7·16	— 4·36	N
Achola . . .	18-14-44·91	·075	39	18-14-48·12	— 3·21	N

The mean probable error, not including Rajpur and Dehra, is ± ·056. The only abnormally larger probable error is that at Achola, and the adverse circumstances which prevailed at this station are quite sufficient to account for it.

The most noticeable point in this table is the magnitude of the differences between the astronomical and geodetic values of latitude at Colaba, Khanpisura, and Kanheri.

The apparent error in the value of the micrometer screw has been determined for each station by comparing the resulting values of latitude obtained when the micrometer correction was positive with the resulting values of latitude when the micrometer correction was negative. The apparent error in the value of the micrometer screw at each station is given below:—

Colába	—0.″00205	too small
Mándvi	—0·01187	,,
Dhauleshwar	—0·00300	,,
Khánpisura	+0·00278	too large
Kanheri	—0·00563	too small
Nitalli	—0.00668	,,
Achola	—0·00018	,,

per 100 divisions.

Mean—0.″00381 per 100 divisions.

The following table shows the difference in resulting values of latitude when the pair of stars is observed east to west and when the pair is taken west to east (*i. e.*, telescopic position). It will be seen that the same pair of stars when observed east to west always gives a larger value of latitude than when observed west to east:—

Stations.	Latitude E. to W.	Latitude W. to E.	Difference (E. to W.)—(W to E.
Rajpur	30°-23′-9″·31	30°-23′-9″·21	+0″·10
E. end Dehra base	30-16-37·42	30-16-37·21	+ ·21
Colába	18-53-39·14	18-53-39·11	+ ·03
Mándvi	18-37-48·09	18-37-48·03	+ ·06
Dhauleshwar	18-25-42·97	18-25-42·84	+ ·13
Khánpisura	18-45-22·58	18-45-22·50	+ ·08
Kanheri	18-29-22·01	18-29-21·81	+ ·20
Nitalli	18-17- 2·79	18-17- 2·72	+ ·07
Achola	18-14-44·99	18-14-44·85	+ ·14

TIDAL AND LEVELLING OPERATIONS.

Extract from the Narrative Report of LIEUTENANT-COLONEL J. HILL, R.E., *in charge No. 25 Party,—Season 1892-93.*

During my visit to Mergui early in February 1893, I took the opportunity of completing the spirit-levelling connection between the tidal observatory and the Mergui base-line of verification. I also went up the Tenasserim river one morning in a steam launch to Zedawún to look at the base-line. Its west pillar is about three miles from the landing place at Zedawún, and as it was exactly noon at the time of my arrival, and I was on foot, I only found time to inspect that pillar and was unable to go on for another three miles to inspect the east one. I found the west pillar much overgrown with vegetation: a young banian tree in particular had entwined it and required to be removed at once to ensure the safety of the structure. The head man of a neighbouring village who acted as guide said that the east pillar was in a similar condition. I mentioned to the Deputy Commissioner that I should feel obliged by his having both pillars, of which he has the custody, cleared of vegetation; and before I left Mergui he informed me that this had been done. After finishing my tour of inspection I instructed Lieutenant Morice to send a circular to Port Officers and others, asking them for certain information about the tides in their immediate neighbourhoods on the coast required to complete the data necessary for the preparation of an Indian co-tidal chart—a chart I have long wished to construct, and which when completed will, I hope, prove both interesting and useful. Its preparation will be a matter of time, and I do not expect it to be ready for publication before the spring of 1895. I went on privilege leave for two months and twenty-four days, *viz.*, from the 10th July to the 3rd October 1893, both days inclusive. My leave was spent in England, and while there I saw Mr. Roberts at the Nautical Almanac Office, who told me, with reference to his method of calculating the tidal predictions for the riverain ports, that he had sent full particulars to the head-quarters office of the Trigonometrical Branch at Dehra Dun, explaining his *modus operandi* in detail. His method would appear to require modification either in its principle or in its practical application, as will be seen later on. I also went to the India Office and drew attention to the late arrival in India of the Tide Tables for 1893, which caused much inconvenience, and proposed that Mr. Roberts might be allowed to forward the Tide Tables for 1894 to my office direct, immediately after he had

had them printed and bound. While on leave I also finished the descriptions of the tidal observatories for the tidal volume, writing thirteen descriptions at that time.

I take this opportunity of remarking that Colonel G. Strahan's standard sun-dials have proved a very valuable addition to the means available for keeping tidal observatory clocks to correct time. At Muscat, where there is also a good chronometer, the sun-dial observations again and again assign the same rate to it in a manner that leaves no doubt that both instruments are reliable within a very few seconds. At Minicoy the rate assigned to the chronometer by the sun-dial, though slightly variable from day to day, is very fairly accordant with the rate assigned by astronomical observations when some weeks have elapsed between the days of observation. At Mergui, where the chronometer became useless and had to be sent to Calcutta, the sun-dial, though of an early pattern, slightly deficient in solidity, can always be depended upon within two or three minutes, and has afforded a means of keeping the clocks to time in a much more satisfactory manner than by the old method of ascertaining the time from the chronometers of vessels calling at the port. At Poona a standard sun-dial constructed to the latitude of the office of the tidal and levelling operations has been observed with on a pillar built for the purpose in the office compound last month: several individuals have observed the time of noon by means of it, and it has been proved that the moment of noon can be determined by it within about 15 seconds of the truth.

Tidal Operations.

During the survey year under review, tidal operations by means of self-registering gauges were carried on at fourteen stations, namely, *Aden*, Muscat, Bushire, *Kurrachee*, Bhávnagar, *Apollo Bandar (Bombay)*, Prince's Dock (Bombay), Minicoy, Tuticorin, Trincomalee, *Kidderpore*, *Rangoon*, Mergui, and *Port Blair*. The eight tidal stations whose names are not italicised are minor stations, where observations, as a rule, are taken for five years only. Among them Prince's Dock is included, as the continuance of its registrations beyond the limit of five years is not required by the general scheme of tidal operations, although the utility of the registrations to the officials connected with the docks is such that they appear likely to be continued indefinitely. The six stations whose names are italicised are permanent stations, where the minimum period of observations lasts for 19 years, and where observations should continue to be taken until the work at all the stations is completed. In addition to the automatic observations taken at the stations enumerated above, personal tidal observations to graduated staves were taken daily, with the object of comparing the actual heights and times of high and low water with those predicted in the tide tables. This was done at the following tidal stations, at all of which the tidal observatories are closed: Cochin, Tuticorin, Colombo, Cocanada, Chittagong, Akyab, Moulmein. At Galle the range of the tide is so small, and the water usually so rough, that precise personal observations are impracticable, but the Master Attendant has undertaken to report any appreciable error in the predictions.

At Tuticorin the tidal observatory was closed on the 19th June, five years' observations having been completed.

New tidal observatories were established at Muscat and Bushire: registrations were commenced at Muscat on the 6th February 1893, and at Bushire on the 22nd November 1892.

It will be seen from the foregoing, combined with the particulars given in previous annual reports, that since the resumption of tidal operations systematically in 1877, observations have been taken at 33 tidal observatories, of which 20 (including Madras) have been closed on the completion of their registrations and 13 are now in operation.

During the survey year 1893-94, tidal observations will be continued at the following stations, where they are now in progress, *viz.*, Aden, Muscat, Bushire, Kurrachee, Bhávnagar, Apollo Bandar and Prince's Dock, Bombay; Minicoy, Trincomalee, Kidderpore, Rangoon, Mergui and Port Blair, of which Bhávnagar will be closed in January 1894, and Mergui in March 1894 on the completion of the required series of tidal registrations. The resumption of tidal observations at Madras has been permitted, and the tidal observatory will, it is hoped, be completed at an early date: the tidal observatory at Diamond Island in Burma is ready, and the instruments will be set up early in the approaching field season: the tidal observatory at the new site at Port Albert Victor in Káthiáwár will be opened when the State Engineer of Bhávnagar completes the light-house, which is designed to contain the observatory.

In my last annual report I expressed a hope that it might be possible to commence tidal observations at Diamond Island in Burma, where the preliminary work has been for the last two-and-a-half-years in the hands of the Executive Engineer of Bassein. The work was of a difficult nature and could not be completed within the time I expected; but I am glad to be able to state now that the Executive Engineer has finished his work, and that one of Mr. Belcham's first duties, during the field season about to commence, will be to proceed to Diamond Island to set up the tidal apparatus and start the observations. In March 1891 an estimate, amounting to ₹2,464, was prepared by the Public Works Department for the work at Diamond Island, which it was then arranged should be begun in the following month. I have not as yet heard what the work has actually cost, but it proved so much heavier than was at first anticipated that the estimate had to be largely increased. I visited Diamond Island on the 17th January to inspect the works there in progress,

and to discuss personally with the Executive Engineer of Bassein, Mr. Harman Tyndall, the special difficulties of completing the undertaking. I was struck with the ingenuity of his proposals for keeping open a free communication with the sea and approved of them; and I have no doubt that when the tidal observations are being started, the observatory and its system of communication with the sea will afford a proof of the skill and care bestowed on them by Mr. Tyndall.

My thanks are due to the Director of the Royal Indian Marine for his courtesy in enabling me to visit Diamond Island and Port Blair in Her Majesty's Indian Marine ship *Dalhousie*, and to the Chief Commissioner of Burma for permitting the *Dalhousie* to extend her tour to Port Blair in order to enable me to make my inspection there, and bring Surveyor Dhondu Venayek and his men with me to Rangoon, thus saving me a fortnight's delay.

I shall now describe briefly the working of each tidal observatory, commencing with Aden and following the order of the stations round the coasts to Burma, including in this survey those stations where, in lieu of automatic tidal observations, personal observations to a graduated staff are taken daily in order to furnish comparisons between the actual and the predicted heights and times of high and low water.

Aden.—The year's observations at this station have been highly satisfactory. The Port Officer's supervision of them is most efficient, and the tidal observatory clerk is performing his duties correctly. It is also a pleasure to me to be able to state that my expectations (referred to in my last annual report) of being able to utilise the rejected tidal registrations for the year March 1890 to March 1891 have been fortunately realised. I mentioned in my last annual report that the piles supporting the observatory were very much worm-eaten, and that I had addressed the Political Resident on the subject. He made the necessary communication to the Port Trust Board, and they agreed to renew the piles and render the structure permamently secure. I then sent Mr. Belcham to Aden to superintend the work and ensure its being performed without causing a gap in the registrations. He was there from the 5th May to the 18th June, and in that interval he inspected the observatory in the regular manner, dismantled the instruments and set them working in a temporary house on the pier adjacent to the observatory, superintended the renewal of the supporting piles, the outer piles and braces, etc., protecting the observatory, and re-started the instruments within that building after moving them back to their old positions in it, and setting up a new iron float cylinder. The observatory stands over exactly the same spot as before, and the new piles supporting it are protected with copper sheathing. The new float cylinder is twenty-two inches in diameter and fourteen feet long; the bottom of it rests on concrete and the top rises one foot six inches above the observatory floor. Communication is through a hole, one inch in diameter, bored eight inches above the bottom and protected with a disc of wire-netting. The spring regulator clock belonging to the tide gauge, and mentioned in my last annual report, had been thoroughly repaired in Poona and was again attached to the instrument in place of the pendulum clock that had been in use since July 1892, but the latter clock is being kept in the observatory in reserve in case of any accident occurring to the other. Before Mr. Belcham left Aden all the usual measurements and levelling were carried out, and the present positions of the bed-plate and zero of the gauge made practically identical with their previous positions; and all the instruments were left clean and in good order. Throughout the year the tide gauge worked without any serious interruption. One break of sixteen hours occurred in January, caused by the breaking of the wire carrying the driving weight, another of 19 hours took place in the following month, through the bending of two teeth of the escapement wheel, and in April the cord of the pencil weight broke and the new one did not work properly for 24 hours; such other breaks as occurred were quite unimportant. The auxiliary instruments also worked very satisfactorily. Mr. Belcham states that during the repairs to the observatory the standard mercurial barometer was affected in a peculiar manner by the hammering of the piles: the reading was on several occasions during the pile-driving found about 0·3 inch lower than that of the aneroid; but after turning the adjusting screw until the column of mercury reached the top of the tube and inverting the instrument, it was found, on re-adjustment, to accord with the aneroid on each occasion. I am indebted to Commander E. R. Shopland, R.I.M., the Port Officer, for his superintendence of the operations and his assistance during the repair of the observatory, and to Mr. W. Child, the Port Trust Engineer, for his skilful execution of the work.

Muscat.—The position chosen for the new tidal station at Muscat, near the eastern extremity of Arabia, is the site just outside Muscat cove on the southern side of the inlet known as Moghab (where the Red Sea and Kurrachee telegraph cables were landed), which I stated in my report No. 451, dated 23rd May 1891, would probably, when properly adapted, be the best and most convenient site for a tidal observatory. The site, in an indentation in the rocks, is naturally protected from northerly and westerly winds, and, by closing the indentation by a stone dam, protection is obtained during easterly winds, when the sea runs up the inlet with considerable force.

The observatory which has been erected at this site is about 200 yards to the south-east of the British Consulate, and is approximately in latitude 23° 37′ north, and longitude 58° 36′ east. According to the arrangements mentioned in my last annual report, Mr. Belcham, after finishing his work at Bushire, proceeded to Muscat, where he arrived on the 17th December and examined the coast all about the town and neighbourhood,

particularly the sites mentioned in my report No. 451, dated 23rd May 1891, and finally selected the site in the Moghab inlet described above.

With the Political Agent's sanction he commenced building a dam to secure smooth water at the tidal observatory. After considerable difficulties caused by the unruliness of the workmen and the roughness of the sea, the dam and observatory were erected, the instruments placed in position, and registrations fairly started on the 6th February 1893. The Political Agent in a letter addressed to me, and dated 25th February, remarked as follows: "Mr. Belcham's work appears to me to have been thoroughly well done; he had several difficulties to contend with in connection with the building of the tide gauge-house, and the workmen were not always easy to manage. I think that the result of his work here does credit to his perseverance and ingenuity." The observatory-house, supplied by Mr. W. W. Squire, the Engineer to the Bombay Port Trust, is uniform with that sent by Mr. Squire for Bushire, and is specially designed to be of great strength and very easy to erect. Each portion of timber, etc., was lettered or numbered, and the whole was fitted together as indicated by corresponding key-plans. In the erection of these observatories the carpenter supplied to Mr. Belcham by Mr. Squire was of the greatest use. The substantial wooden cabin thus constructed is 12 feet square, and is supported on two horizontal rails resting on six uprights, five of which are cemented into holes cut in the rock, and the remaining one is supported by a rail spanning the indentation in the rocks, which gives 3 or 4 feet of water immediately under the observatory at the lowest tides. The indentation is about 50 feet long and 25 feet wide at its mouth, which is on the north, and 11 feet wide under the observatory, which is nearly at its centre. The southern extremity of the indentation does not ordinarily admit any water; but in case any inward rush of water through it might occur in very bad weather, it has been dammed by a rough stone wall. To break the force of water rushing in from the north, two massive palisades of beams and rails have been erected across the indentation and just north of the observatory. The palisades are 5½ feet apart, and the space between them has been filled in with heavy stones up to about 2 feet above high-water mark: the northern side of the dam, thus formed, is protected by a mass of stones built up to about low-water mark. In building this dam, a shaft about 9 inches square in section was left across the bottom, or 4 feet below low water, to ensure clear communication between the enclosed indentation and the sea. The cylinder is of iron, 15 feet long and 2½ feet in internal diameter; its bottom is about 3 feet below the lowest tides, and its top about 3 feet above the highest. It rests on the rock and on two short lengths of rail at the bottom, and is braced to the frame work and the rock. The floor of the observatory being 2½ feet above the top of the cylinder, the intermediate space has been closed by a wooden casing 2 feet square, bolted to the iron cylinder. The communication is through four ½-inch perforations in a ½-inch iron plate closing the bottom of the cylinder. This plate is in two semi-circular pieces for convenience of removal if necessary. The working scale of the tide-gauge is one-third: it is one of Adie's instruments, modified by Légé & Co., and was last used at Cocanada tidal station.

A vertical graduated staff 11·3 feet in length and divided into lengths of feet has been fixed to the south side of the dam: its zero is identical with that of the tide-gauge, and it is read daily so that no retardation can take place undetected. The auxiliary instruments have been set up in the British Consulate. The aneroid is set up on a bracket against the southern wall of the open courtyard and the mercurial barometer beside it on the right. The anemometer and the rain-gauge are set up on the roof of the Consulate. The observatory clocks are regulated by a standard sun-dial of Colonel G. Strahan's pattern, set up on a masonry pillar in the small garden opposite the southern verandah, kept under lock and key and in charge of the guard.

Registrations were commenced on the 6th February and have been very satisfactory, only six short interruptions, each of less than seven hours, having occurred: these were due to the pencil traveller jamming between the parallel slides. The auxiliary instruments have worked continuously. The clerk in charge is F. X. Monsurate, who was previously employed at Cochin, and who performs his duties very satisfactorily. In addition to his tidal work, he also furnishes meteorological records to the Meteorological Reporter to the Government of India. Major Hayes Sadler, Her Britannic Majesty's Consul and Political Agent at Muscat, has cordially assisted our operations from the first, and it is largely due to his help that the observatory has been started so successfully.

Bushire.—This new tidal observatory in Persia, near the head of the Persian Gulf, is situated nearly six miles south of the town of Bushire at Reshire Point. It has been built on the rocks below the cliff, and is about a hundred yards to the west of the cable-house of the Indo-European Telegraph Department. The principal Bushire office of that Department is also at Reshire, about three-quarters of a mile north-east of the tidal observatory. The observatory is approximately in latitude 22° 59′ north, longitude 50° 45′ east. The arrangements for the establishment of this tidal observatory were mentioned in my reports for 1890-91 and 1891-92, in the latter of which I stated that at the date of the report the masonry portion of the observatory had been finished under the direction of the Mr. R. H. New, the Assistant Superintendent of Telegraphs in charge at Bushire.

Mr. Belcham, according to the arrangement mentioned in the latter report, proceeded to Bushire to put up the tidal observatory and start the observations. He was employed at Bushire on this duty from the 28th October to the 12th December 1892. In this interval

he erected the wooden cabin, set up and started all the instruments, and instructed two telegraph clerks thoroughly in their duties.

A well, 10 feet square, has been hewn out of the rock to a depth of 7 feet, or 3 feet below the lowest tides. A mass of masonry, decreasing from 23 feet square (outside measurement) at the base to 20½ feet square at the top, has been erected upon the sides of well, so as to give it a total depth of 15½ feet. The observatory is placed over the top of this well, with its floor about 6½ feet above the highest tides. The mass of masonry has been carried up to a further height of 2 feet round the observatory walls to protect them from the sea, and a wall of loose stones has been raised against the southern face of the masonry to give additional security in heavy weather. The observatory is a substantial wooden house, 12 feet square, supplied by Mr. W. W. Squire, the Engineer to the Bombay Port Trust, and of the same design as that supplied by him for Muscat. It is entered by an inclined bridge from the rock below and is accessible at all tides. The cylinder is of iron 30, inches in diameter and 15 feet long, and is placed in the north-west corner of the well, resting on two pieces of rail at the botttom, and secured to the floor of the observatory at the top: the bottom of the cylinder is closed by an iron plate with five ¾-inch communication holes. A horizontal iron pipe, 47 feet long and 8 inches in internal diameter, leaves the well one foot above its bottom, and passes through a tunnel in the rock to the sea. At its outer end it rests on the stones, and is protected by a movable copper grating. The working scale of the tide-gauge is one-half: the instrument is one of the old pattern by Adie, modified by Légé & Co., and was last used at Cochin: it has a regulator clock with English lever escapement and special mechanism for stopping and re-starting it.

A graduated staff, 9 feet in length, was prepared but had to be left in the observatory, as the people frequenting the spot, who stole the very hooks from outside the windows, would have stolen the staff had it been erected outside the observatory in the usual manner.

The aneroid and mercurial barometers have been set up in the telegraph office, and the anemometer and rain-gauge have been placed on the roof of the same building. The observations commenced on the 22nd November, and have been most satisfactory up to the present. Mr. F. Johnson, one of the senior clerks at the telegraph office, was deputed as clerk in charge of the tidal observatory, and performed the duties well, until his transfer on the 10th June necessitated his handing over the work to Mr. J. Wartenby, another senior clerk in the same office, who had been instructed by Mr. Belcham as a precaution against such contingencies. Owing to the distance from the telegraph office, two visits per day, at 9 A. M. and 5 P. M., instead of the usual four visits, are made by the tidal observatory clerk. From May to September the visits are at 6 A.M. and 6 P.M. My best thanks are due to Mr. R. H. New for the great trouble he took in carrying out, under many difficulties, the troublesome work of preparing the site for the reception of the tidal observatory and instruments, for the assistance he afforded during the starting of the observatory, and the supervision he exercised over its working until his transfer to Kurrachee in June, since when Mr. T. Y. Johnstone, Superintendent of Telegraphs, has kindly carried on the supervision.

Kurrachee.—The tidal observations at this station have been quite satisfactory throughout the year, and particularly good during the latter half of it. The auxiliary meteorological observations have also been very satisfactory. Mr. Morris, the Port Engineer, continues his supervision of the work, and in consequence of his excellent arrangements interruptions in the registrations are reduced to a minimum. In my last annual report I mentioned a peculiar distortion of the tidal curves occurring in March and April 1892 at extreme high tides. The fact that the tops of the abnormal curves, though irregular and serrated, did not rise above a well-marked maximum of 12 feet above the zero of the gauge, instead of exceeding that height as they would have done had they remained regular, seemed at first to point to something faulty in the mechanism of the tide-gauge, especially as an inspection of the curves made it clear that the peculiarity was not due to imperfect communication. In October, Mr. Belcham, while on his way to Bushire, found time to pay a short visit to the observatory with a view to discover the cause of the distortion of the curves; but the time at his disposal was too brief to enable him to succeed. Other distortions occurred in November, December, and January last at extreme low tides, when the curves became perfectly flat-bottomed on reaching a minimum level of one foot above the zero of the gauge, instead of falling below that level as they would have done had they been regular. For some time the harbour had been silting up in the vicinity of the tidal observatory and a large quantity of mud had formed round it. In December the Port Engineer caused the part of the accumulation (which the clerk thought was affecting the communication) to be removed; but this did not restore the curves to their normal state, for the distortions recurred early in January. A telegram and letter were therefore sent from my office in Poona on the 14th January, which led to the total clearing away of the accumulated mud from around the observatory, to the flushing out of the cylinder, and to the removal of an unsuspected deposit of solid mud at the bottom of the cylinder that had formed within it to a thickness of three feet. This deposit was removed on the 28th January, and precautions were taken against any accumulation remaining unnoticed in future, and since that date the tidal curves have been normal. Their distortions were exactly such as would be caused by the counterpoise weight of the float resting on the deposit of mud at extreme high tides, and by the float resting upon it

at extreme low tides, and no doubt they were due to these causes. The observatory was regularly inspected by Mr. Belcham in March. The float-band and counterpoise chain, which had been in use since 1888, were so much damaged from corrosion that they had to be replaced by new ones. The clerk was directed to ascertain the condition of the bottom of the cylinder and the communication by means of monthly measurements inside and outside the cylinder, taken from the level of the bed plate, and to report any accumulation of mud to the Assistant Engineer with a view to its immediate removal. At the close of the inspection the instruments were left clean and in good working order.

Bhávnagar.—At this station the tidal registrations have been satisfactory throughout the year, no interruptions to them of any importance having occurred; the barometrical registrations have been fairly satisfactory and call for no special remark; and the anemometrical registrations have been very satisfactory. The observatory was inspected by Mr. Belcham between the 7th and 11th March. He reported that it was in excellent order. He had all the instruments cleaned and perfectly adjusted, and carried out the usual measurements and levelling. My best thanks are due to Mr. Proctor-Sims, the State Engineer, whose arrangements have enabled the Bhávnagar observations to be successfully continued. I am also indebted to his nautical assistant, Captain F. M. Godrich, who immediately supervises the work and visits the observatory daily.

Apollo Bandar, Bombay.—The observations at this most satisfactory station have been uninterrupted and practically perfect throughout the year. On reference to previous annual reports it will be found that this gauge has worked without an interruption since November 1886, except of course during the short intervals for cleaning at the annual inspections; and on such occasions the continuity of the curves was preserved by means of supplementary personal observations. This is a remarkable and gratifying record. I visited the observatory in November in order to take some zero measurements required for the tidal computations, and I then mentioned to Mr. Squire, the Engineer to the Port Trust, that I considered an ordinary graduated staff for comparing the level of the water inside and outside the cylinder would be preferable to the special contrivance, mentioned in my last annual report, which was still being experimented with. After further trial and modification of it, he came to the same conclusion and it was removed in January, the readings being afterwards taken to a scale of feet cut on the outer face of the Bandar, pending the erection of an ordinary graduated staff. On the 4th and 5th November at very low tide the float grounded for a few minutes. On the 6th and 7th November and the 3rd December large quantities of mud were removed from the well. In February, the old wooden observatory, then quite dilapidated, was pulled down, and the gauge during this operation, and while a new observatory was being built over it, continued working regularly within a wooden casing made for its protection. The new observatory was completed on the 3rd April. It is of an ornamental design, in keeping with that of the neighbouring pavilion on the Bandar. Its timber framework is filled in with red brick work. The plan of the old observatory (a dodecagon) is retained; but the pointed shingle roof is higher than the old one, and the observatory is consequently cooler and more airy.

On the 10th April I visited the new observatory, which appeared to me a great improvement on the old one, and well adapted to its purpose, and under my instructions Surveyor Dhondu Venayek carried out the details of the usual annual inspection. The tide-gauge was naturally found very badly in need of cleaning, but it had sustained no damage during the renewal of the observatory and all its parts were sound. A new graduated staff for comparing the level of the water inside and outside the cylinder was fixed against the Bandar wall to the west of the observatory: its length is 16 feet 3 inches and its zero is 5 feet above the zero of the gauge, or 75 feet above town hall datum. The manner in which Mr. Squire carried out the renewal of the observatory without causing any interruption in the tidal registrations is a most gratifying and satisfactory subject for report, and I shall have occasion to mention his name again in the following paragraph dealing with the tidal observatory at Prince's Dock. Auxiliary instruments are not employed at either of the Bombay tidal observatories, as the necessary meteorological observations are taken at the Colaba Observatory.

Prince's Dock, Bombay.—At this station the tidal observations have continued to be very satisfactory on the whole, and, apart from an unavoidable break of four days, occurring while the position of the tide-gauge was being changed, the few short interruptions that have taken place have been due to slight inherent faults in the design of the tide-gauge, which were noticed in my last annual report. I mentioned there that the float-band, pencil-wire, and some other parts of the mechanism are too frail, and I might have added that the diagram paper is so very thin (in order to roll up and unroll easily and not to be too bulky when wound round the cylinders) that it is very liable to damage. Twice during the year it was torn by the zero-pencil, which had been weighted rather too heavily by the clerk with the object of improving its marking. Among some unimportant interruptions to the registrations, one of three hours' duration occurred in March, caused by the hand sticking on the stud-wheel: it was not detected until the diagram paper was taken off and unrolled in the following month, thus exemplifying one of the faults in the design of the gauge to which attention was drawn in my last report. I visited the observatory in April with a view to bringing down the tide-gauge from the upper story of the light-house to the ground floor. The light-house dynamo had

been removed from the ground-floor into another building, and could not therefore affect the tide-gauge clock; and the lowering of the position of the gauge, besides its general convenience, rendered it unnecessary to go on using an objectionably long float-band, which was unavoidable so long as the gauge remained in the upper story. After making the necessary arrangements with Mr. Squire I returned to Poona, and Surveyor Dhondu Venayek remained in Bombay to assist in changing the position of the gauge and to adjust it, and carry out the usual measurements, levelling, etc., of an inspection. I afterwards inspected the work and found it well done: it caused an interruption to the observations of four days. I may remark that a new zero-pencil-holder of simple design and improved make was attached to the gauge and has worked quite satisfactorily, no tearing of the diagram paper by it having occurred since its attachment, and the marking of the zero-line being clear and continuous. I am much indebted to Mr. Squire for his continued assistance in maintaining both the Bombay tidal observatories in their efficient state. I mentioned in my last report that timber observatory houses, iron float-cylinders, a large communication pipe, etc., had been made in Bombay and forwarded to Muscat and Bushire under Mr. Squire's personal supervision. I am now able to state that they have been found to answer their purposes admirably. His assistance was most valuable, and I feel particularly grateful to him.

Cochin.—At Cochin, Mr. H. Woodhouse has succeeded Captain Winckler as Port Officer, and kindly continues the work, which Captain Winckler undertook, of sending monthly tabulated comparisons of the times and heights of high and low water during daylight, obtained from readings on a graduated staff in the manner described in last year's report on this station. The last such statement received is that for August 1893, and it appears that, assuming the correctness of the Port Officer's time, the predictions, which were satisfactory up to the date of my last report, have since then become increasingly too early. The height predictions continue to be satisfactory.

Minicoy.—The observations at this station have been very satisfactory throughout the year. Besides the usual stoppage for cleaning, the tide-gauge record has only been interrupted on three occasions, each stoppage lasting less than five hours. On the last of these occasions, the clerk having discovered that excessive pencil oscillation was arising, owing to the appearance of a large hole four inches wide in the wooden bottom of the cylinder, stopped the gauge for the purpose of fitting a round coral stone, 4 inches thick, into the bottom of the cylinder. This stone has a $1\frac{1}{4}$ inch perforation and works very well. The aneroid worked with only one interruption of forty minutes, owing to the clock stopping. The anemometer clock stopped four times, on each occasion for less than a day. On two occasions this was due to two ants, which were found jammed in the escapement. On one day the curve was lost owing to the clerk having forgotten to lower the spiral. The observatory was inspected by Surveyor Dhondu Vinayek between the 1st and the 19th December. By the courtesy of Commander C. F. Oldham, R.N., in charge Marine Survey of India Department, he was taken to Minicoy on board Her Majesty's Indian Marine steamer *Investigator*. Commander A. Channer, R.N., the Superintendent, Imperial Light Service, Ceylon and Minicoy, kindly brought him back to Colombo on the S. S. *Lady Havelock*. He found everything in good order, examined and cleaned all the instruments, tested the standard sun-dial, by which the clocks are corrected, by comparing it with the *Investigator's* chronometer, and performed all the usual measurements and levelling. The connecting hook of the float was much corroded, and the chain was broken from the same cause: these parts were renewed. A very slight change in the working zero was observed, due probably to stretching of the pencil chain. The gangway leading into the observatory was strengthened. On three occasions the guys of the anemometer-house were cut by some of the islanders: the circumstance was reported to the *amin*, and no such mischief has been done subsequently. The cocoanut piles of the anemometer-house were found rotting, so the clerk was ordered to build a stone wall within them to support the structure. The observatory piles appeared to be quite sound. Our thanks are due to the Collector of Malabar for kindly forwarding the pay to the observatory clerks, and assisting them further by sending them their provisions from Calicut. I am also much indebted to Captain Channer for his continued assistance in bringing away the records and reports from the observatory and carrying letters, etc., to and from the clerks on his periodical visits to the island. The clerk has again been awarded a sum of money in acknowledgment of the value of his reports on storms to the Meteorological Reporter to the Government of India. This year there were only two storms, neither of them very remarkable, so he only received ₹5.

Tuticorin.—At this station all the observations continued perfectly satisfactory, until the closing of the observatory after the completion of five years' registrations. The tide-gauge worked throughout the year without any interruption, so also did the anemometer, and the aneroid experienced only one trifling interruption, when the clock-spring broke on the 5th January and was re-started with a new spring in $2\frac{1}{4}$ hours. During the whole five years of the observations, the tidal record at Tuticorin has been practically perfect, the barometric record equally so, and the anemometric record only faulty during one period, between November 1891 and March 1892, when, as described in my report, the direction of the wind was imperfectly recorded owing to the wearing away of the endless screw of the steering vanes. This is a very creditable record.

Five years' observations were completed on the 7th June, and the observatory, after being regularly inspected, was dismantled and closed on the 19th June by Surveyor

Dhondu Vinayek, who had also, while travelling from Colombo to Poona in the previous December, taken the opportunity to visit the observatory and take zero measurements. After dismantling the observatory, he carefully packed all the instruments and brought them back to Poona with all the completed diagrams, books, etc. Before leaving Tuticorin he handed over the observatory-house and furniture to the Port Officer, and attached a graduated staff of the usual pattern to one of the piles of the jetty, leaving also a spare staff of the same pattern for future use. Since the removal of the tide-gauge, tidal readings to the graduated staff (the zero of which coincides with that of the tide tables) are being taken daily under the Port Officer's direction: he sends them to my office monthly, compared with the corresponding predictions given in the tide tables.

Captain Baker, who has been Port Officer at Tuticorin since June 1889, has always done his utmost to secure the success of the tidal operations, and I am much indebted to him. In my last two annual reports examples were given of the relatively powerful effect of wind on the level of the water at Tuticorin. A single but striking instance of the same action was noticed during the past year. On the 23rd April, during neap-tides, the average range of which is only about 9 inches, the wind was variable and there were several peculiar abnormal rises and falls of the tide, none of which exceeded about 4 inches; but a little before 7 P.M. the wind began to blow with great force from the north, and the tide, which was on the fall, suddenly stopped falling and then rose to 4 feet 4 inches above zero—a spring-tide height and a rise of 1 foot 8 inches in an hour, when a gentle fall of 2 inches in an hour might have been expected. During this hour 50 miles of wind were recorded. In the next hour the wind blew nearly as hard but veered to the north-east, and the tide fell right down to 1 foot 8 inches above zero, or its normal height —a fall of 2 feet 8 inches. Between 9 and 10 P.M. the tide again ran right up to 3 feet 5 inches above zero, an abnormal rise of 1 foot 9 inches, although the wind, blowing from the same quarter, was moderating to 16 miles per hour. Between 10 and 11 P.M. the tide again ran down nearly to its normal position, while the wind veered though east and south to south-west and moderated to 10 miles per hour. By midnight the tide had fallen to its normal position and resumed its normal rising motion; but for the next six hours, though there was very little wind, the tide rising and falling as much as 9 inches at a time, gave a peculiar zig-zag appearance to the diagram.

Colombo.—In December last I addressed the Colonial Secretary at Colombo, pointing out that daily observations of the actual times and heights of high and low water at Colombo and Galle (where systematic tidal observations were taken between 1884 and 1890), compared with the predicted values given in the tide tables, would afford a means of improving the latter, and suggested that the Master Attendants could supply such information on printed forms issued from my office. He issued instructions to them that the forms should be filled in and sent to my office, and Captain Donnan, the Master Attendant at Colombo, has forwarded them regularly since January. They show a good accordance between actual and predicted values, and I am much obliged to him for sending them.

Galle.—As the preceding paragraph explains, Captain Blyth, the Master Attendant at Galle, received instructions from the Colonial Secretary at Colombo to furnish me with comparisons of the actual and predicted times and heights of high and low water during daylight. Captain Blyth represented to me that the range at Galle is so small and the sea so rough that it is very difficult to determine the time and height of high and low water with any precision. He undertook however to test the published tide tables daily, and report any sufficiently marked difference between the actual and predicted tides. Under the circumstances this arrangement seems a sensible one, and I am much obliged to Captain Blyth for undertaking to apply the test himself.

Trincomalee.—The observations at this station have been highly satisfactory throughout the year. There has been no break in the tidal registrations; and the auxiliary instruments have also given very good results.

The aneroid only stopped once, in November, and was re-started in eight hours. The anemometer clock stopped five times; the longest interruption was for seven hours: the cause was generally the accumulation of coal-dust in the works, and since the removal of the instrument to a new position there has been but one stoppage. I inspected the observatory in March and found all the instruments working well.

I took the opportunity of removing the anemometer, which was not exposed to the free action of the wind, and which suffered considerably from coal-dust, and placing it on Fort Ostenburgh, immediately above the tidal observatory, in a small teak house built for its reception, and situated on the old parapet 58 feet to the south of the flag staff. I had also intended, for reasons given in last year's report, to set up one of Colonel G. Strahan's standard sun-dials at the observatory. The instrument was sent by the S. S. *Lady Gordon* (consigned by Messrs. Wilson and Co., Madras, to the Naval Storekeeper) on the very occasion, on which I travelled by her to Trincomalee. But by some mismanagement it was not landed, and the vessel continued her voyage with the sun-dial on board. I was able to see a pillar prepared for its support, 13 feet east of the tidal observatory, and Captain Paterson, R.E., kindly undertook to set up the instrument when received, and see that the clerk understood and carried out the written instructions that I left for his guidance. I wrote to Captain Paterson on the subject in April, but as yet the sun-dial has not been used for checking the time kept by the instruments in the observatory.

I am much obliged to Mr. Millett for the supervision he exercised over the observatory until January, when Mr. J. Forsey, who had been appointed Naval Storekeeper, relieved him and kindly undertook to carry on the work.

Madras.—At this station tidal observations, which were discontinued in October 1890, have not yet been resumed, although their resumption was sanctioned by the Board of Harbour Trustees in January last. The subject has been touched upon above, and I think it will be convenient if I give here a summary of the negotiations, etc., that have taken place since the date of my last annual report (1st October 1892). Colonel G. Strahan, Deputy Surveyor-General, in his letter No. 2584, dated 4th October 1892, informed me that he was in communication with the Madras Harbour Trust Board; and the Officiating Surveyor-General, in his letter No. 2638 S., dated 21st October 1892, directed me to visit Madras and personally explain matters to the Board. On the 12th December 1892 I had a satisfactory interview with the Chairman of the Board. On the following day I wrote a letter (No. 946) to the Secretary of the Board, explaining matters in a convenient way for reference, and requesting that I might be informed, as soon as the Board arrived at a decision, regarding the payment for the erection and maintenance of the tidal observatory. I also wrote a letter (No. 947) to the Deputy Surveyor-General, informing him what I had done and suggesting that there did not now appear to be any necessity to put a proposal before the Madras Government or to ask them to meet the cost of the tidal observations. Colonel G. Strahan, Deputy Surveyor-General, in his letter No. 3282, dated 20th December 1892, expressed his satisfaction. The Secretary, Harbour Trust Board, in his letter No. 3853, dated 31st January 1893, informed me that the Board had sanctioned the erection of a tidal observatory in the harbour, which was to be in charge of their Engineer and its cost of up-keep to be borne by the Trust. The decision of the Board was communicated to the Deputy Surveyor-General, who expressed some doubt as to whether the Board had consented to supply funds for erecting the tidal observatory. On the 17th March, while passing through Madras on my way to Poona, I called on the Engineer to the Harbour Trust Board to have this point cleared up, and he informed me that all expenses, including that of erection, would be borne by the Trust, and that if I would send him drawings of the observatory (which it was arranged was to be a temporary one to work on the iron pier until a permanent observatory was built on the northern arm of the harbour), he would have it put up in a few weeks after receipt of the drawings. In my letter No. 343, dated 20th March, I informed the Deputy Surveyor-General that the cost of erecting the tidal observatory would be borne by the Harbour Trust Board. I sent the drawings asked for to the Engineer, Harbour Trust Board, in my registered letter No. 391, dated 30th March, but as yet I have received no communication from him. Lastly, the Government of India, in their letter No. $\frac{872}{37}$, dated 20th April 1893, Revenue and Agricultural Department (Surveys), addressed to the Chief Secretary to the Government of Madras, approved of the establishment of the tidal observatory on the terms already mentioned.

Cocanada.—From the time this station was closed in 1891 to the end of the first half of the year under report, tidal observations at high and low water have been taken daily to a graduated staff by the meteorological observer, under the kind superintendence of Captain Wicks, the Port Officer, who has been accustomed to forward to me, regularly, monthly tables of comparisons between these observations and the values predicted in the tide tables. Owing to Captain Wicks' failure to obtain for the meteorogical observer a pecuniary allowance in consideration of this addition to his ordinary duties, the monthly tables heve ceased to be furnished to me since the end of March; and for the future I only expect to receive particulars of discrepancies between the actual and predicted times and heights of high and low water that are sufficiently remarkable to attract the notice of the Port Officer. The comparisons for September 1892, showing discrepancies culminating in one of 2 feet 1 inch, which were very considerable in proportion to the mean range of the tide at springs (5·2 feet), were discussed in last year's annual report. In the following month the discrepancies were even greater, the low tides being as much as 3 feet 5 inches above their predicted values. It is plain, from the information supplied by the meteorological observer, that the abnormal height of the water was caused by cyclonic storms accompanied by heavy freshets. At the beginning of November the discrepancies were almost equally great; and the meteorological observer attributed them to exceptionally heavy freshets in the river. Towards the end of the month the accordance became good, and in the subsequent months excellent.

Kidderpore.—The observations at this station have been carried on throughout the year without a single interruption in the working of any of the instruments, excepting only the necessary stoppage of a few hours for the annual cleaning of each.

I inspected the observatory on the 6th January 1893, and found all the instruments working satisfactorily, except the anemometer; there had been no stoppage of this instrument, but the clerk, Sarada Prasad Das, who was formerly employed at Dublat and ought to have known better, had clogged the instrument with cocoanut oil to such an extent that the cups and vane, owing to the congealing of the oil, no longer moved freely with the wind, and most of the diagrams, from November to January, are worthless as far as their record of very light winds is concerned. The stronger winds seem to have been fairly registered, so that for tidal purposes the record may be considered satisfactory, but it might have

been excellent for all purposes had the clerk confined himself, in accordance with his orders, to the use of Rangoon oil. Surveyor Dhondu Vinayek completed the details of the inspection, supervised the cleaning of all the instruments, carried out the usual measurements and levelling, and left all the instruments clean and in good order on the 11th January.

My thanks are due to Lieutenant Petley, R.N., the Port Officer, who continues to supervise the working of the observatory.

Chittagong.—The tidal observations taken daily during daylight at high and low water to a graduated staff have been continued under the superintendence of Mr. Good, the Port Officer, to whom I am much obliged for his kind co-operation. The last monthly tabulated statement received from him is that for May 1893, up to which, from the date of my last annual report, the comparisons indicate a very fair accordance between the actual and predicted times and heights of high and low water, though towards the end of May the predicted heights were as much as 3 feet too low, probably owing to the early burst of the monsoon and the consequent rise of the river.

Akyab.—The tidal observations taken during daylight at high and low water to a graduated staff have been continued under the superintendence of Captain Pryce, the Port Officer, and since February under his successor, Captain Bishop. I am much obliged to these officers for their valuable assistance. During the year 1892, and throughout the year under report, the comparisons obtained between the actual and predicted times and heights of high and low water by means of the above mentioned observations show that, while the height predictions have remained satisfactory, the time predictions (assuming the correctness of the Port Officer's time) have not been as good as usual, but have been distinctly too early taken as a whole.

Rangoon.—At this station the registrations of the tide-gauge have been most satisfactory throughout the year. During March and April there were three short and unimportant interruptions, none of them lasting more than four hours, due to the breaking of the counterpoise chain of the float. A new chain was put on, on the 2nd June, and has worked satisfactorily. The only other interruption was a trivial one, lasting two hours, caused by the pencil catching in the zero groove on the drum.

The registrations of the aneroid were defective and interrupted until June; but since then there have been no interruptions. On an examination of the diagrams it is evident that the instrument, though fairly accurate and sensitive as a rule, is frequently insensitive for some hours, so that the clerk has to tap the case before the pencil registers the true reading of the barometer. This causes a jerk in the curve, and these jerks recur day after day, frequently measuring as much as $\frac{1}{10}$th inch; combined however with the more reliable mercurial barometer readings at four different hours on each day, the diagrams give a fairly good record for tidal purposes.

The anemometer clock also stopped frequently until my inspection of the observatory in January and February (during the intervals between my visits of inspection to Diamond Island, Port Blair, and Mergui), when it was thoroughly examined and regulated. On the 14th February it was removed by Mr. Reichenbach, the Port Engineer, to a position at the river end of the roof of the tidal observatory, where it has worked well ever since. I was assisted at my inspection by Surveyor Dhondu Venayek in the usual manner, and at the close of it, on the 22nd February, I left all the instruments working well, and the observatory in every respect in a satisfactory condition.

Concurrently with my inspection of the tidal observatory I carried out the arrangements in connection with the Rangoon standard bench-mark; also those connected with the transit observatory erected by the Port Engineer.

My acknowledgments are due to Mr. Darlington, the Vice-Chairman of the Port Commissioners, for the unvarying and practical interest he has taken in the tidal operations; and to Mr. Reichenbach, who has afforded me the greatest assistance ever since he was appointed Port Engineer at Rangoon, for which I feel very grateful to him.

Moulmein.—Captain Dodd, the Port Officer, to whom I am greatly indebted for his long-continued assistance, has as usual sent me monthly statements of the actual times and heights of high and low water observed daily under his direction, and compared with the predictions contained in the tide tables. Until the end of June, with the exception of the time values of a few tides occurring between the 24th and 30th of that month, the accordance between actual and predicted values was satisfactory. But in July the predicted values of low water showed an increasing excessive height, ranging from 2 to 3 feet, more than half the comparisons for the month showing the predicted heights of low water to be over 2 feet in excess. In August this error continued, the average error amounting to 2·0 feet. In my last annual report I gave a table, which was printed on page xxxvi of the appendix to last year's general report, showing the average excess of the predicted heights above the actual heights of the tide at low water in Moulmein during August for the six years 1887—92. The average excess error for those six years was 1 foot 10 inches; the average excess error in August last was as stated 2·0 feet: this is not satisfactory, and I hope that Mr. Roberts will find it possible to utilise the experience of past years so as to prevent the recurrence of such gross errors.

Mergui.—The observations at this station were satisfactory, no interruptions of any importance having occurred in the working of the tide-gauge and aneroid, and the registrations of the anemometer having been absolutely continuous. Most of the short interruptions that occurred were due to stoppages of the clock caused by the congealing

of the cocoanut oil used by the clerk, contrary to orders, to lubricate it. The observatory chronometer stopped in January and had to be sent to Calcutta for repair; but accurate time is obtained from the standard sun-dial, tested by occasional comparisons with chronometers on vessels calling at Mergui; and the clerk, who formerly neglected the sun-dial, as mentioned in my last report, now employs it, according to his instructions, to regulate the observatory clocks.

I inspected the observatory in February, and found all the instruments, with the exception of the chronometer, working well. A certain amount of pumping action of the water inside the cylinder was observable, showing that the sea had too free access to the float, and a European diver with proper apparatus, who happened to be available, was employed to examine the cylinder below water. He found the bottom embedded in hard mud, which had accumulated so as to just cover the third or lowest row of communication holes. All the communication holes were originally 1 inch in diameter. About a foot above the mud he found the holes of the middle row each enlarged to about an inch and three-quarters in diameter, and a foot higher the holes of the top row each enlarged to about 3 inches in diameter. He stopped the latter by winding tarred canvas round the cylinder, with the result that the pumping action in the cylinder was somewhat diminished: this action, though I should have liked to stop it altogether, is of little consequence, as it does not render the curves registered on the tidal diagrams in the least degree confused or illegible. I was assisted in my inspection by Surveyor Dhondu Vinayek, and before I left Mergui all the instruments were thoroughly cleaned and adjusted, and all the usual measurements and levelling were carried out. During my stay at Mergui I had the spirit-levelling connection between the tidal observatory and the Mergui base line of verification completed. Particulars regarding the bench-mark connected will be found later. I have mentioned my visit to the base line and the condition of its pillars already. My thanks are due to Mr. H. G. Batten, the Deputy Commissioner of Mergui, for kindly continuing his supervision of the observatory.

Port Blair.—The observations at Port Blair have been very satisfactory. The tide-gauge worked without interruption, except on the occasions of the periodical cleanings and measurements of the cylinder.

The aneroid worked continuously throughout the year, but an inspection of the diagrams leaves no doubt that the instrument is not sufficiently sensitive. Constantly recurring jerks of as much as $\frac{1}{10}$th of an inch, breaking the curves into lengths approximating to straight lines, indicate that the instrument was not sufficiently sensitive to record the diurnal and weather variations correctly, but had to be tapped by the clerk to make its recording gear act and its readings accord momentarily with those of the mercurial barometer.

As was mentioned in last year's report, the anemometer was sent to my office in Poona for repair; consequently it could not be re-started prior to the inspection of the tidal observatory in January Subsequently there were 15 stoppages of the clock, although it was taken down for repairs in June, causing an interruption of three days. Most of the other interruptions occurred during the night, and none lasted for more than a day. The Meteorological Department can supply the necessary statistics as regards the direction and force of the wind for the periods during which the anemometer was not working.

I inspected the observatory on the 23rd and the 24th January. Most of the details of the inspection had been carried out before my arrival by Surveyor Dhondu Vinayek, who reached Port Blair on the 16th. I found everything in very good order. I arranged with Captain Brookes, the Port Officer, for the erection of a standard sun-dial pillar, and explained to him the kind required, and to Messrs. Ferguson and MacWilliam, the Engineer and Sub-Engineer I left a description of the sun-dial in the tidal observatory for reference; and Captain Marsack, Royal Indian Marine, at my request came to the observatory and saw the arrangements and kindly consented to take the necessary astronomical observations for placing the dial truly in the meridian. The position selected for the sun-dial pillar is close to, and south of, the bench-mark B. The pillar was reported ready by the tidal observatory clerk early in March, but no observations have been reported as yet.

Shaik Mohamed, the tidal observatory clerk, has been performing his duties very satisfactorily. I consider however that an assistant clerk is necessary at a station so isolated as Port Blair, and I requested Captain Brookes to appoint one if possible. I have not as yet heard that the appointment has been made

I am much indebted to Captain Brookes for the interest he has evinced in the work and for the assistance he has afforded me.

From the foregoing it will be noticed that no serious interruption occurred in the observations at any of the tidal stations. All the tidal observatories were inspected. Two new tidal observatories at Muscat and Bushire, remote stations, where considerable difficulties had to be surmounted, were successfully started, and the Aden and Apollo Bandar observatories underwent repairs, almost amounting to complete reconstruction, without any interruption of the registrations. I think I am entitled to report that the tidal operations of the year have been very successful.

Reduction of the Tidal Observations and Extra Tidal Work.

The observations for one year at ten tidal stations and for two years at two tidal stations have been reduced, and the tabulated values of the tidal constants so obtained are appended.

With regard to the commencement made tentatively towards utilising the meteorological records of the tidal observatories for tidal purposes, I have as yet heard nothing on the subject from Mr. Roberts, and consequently the matter still remains in the postponed condition remarked upon in my last report.

The present state of the ordinary tidal computations is shown in the table given below, together with their state at the end of September 1892. The letters A. P. in the table indicate that the actual times and heights of high and low water have been measured from the tidal diagrams or graduated staves and compared with their predicted values published in the tide tables. The actual amount of the usual work done during the year under report can thus be seen at a glance.

The extra tidal and levelling work is not entered in the table. This consisted in supplying information to the Marine Survey of India Department at Bombay to enable them to refer the heights on their charts to high water of ordinary spring tides; in supplying the officer in charge of that department with a table comparing the mean establishments of 34 ports, calculated from the tidal observations, with the vulgar establishments published on the Admiralty charts, with a view to the determination of the more useful statistics; in supplying the Engineer to the Bombay Port Trust with a copy of a certain tidal diagram at Prince's Dock to settle a question that had arisen as to the water available for a vessel at that time; in furnishing the Executive Engineer, Special Defence Division, Military Works, Rangoon, with information as to the data to which tides are referred at Elephant Point and Rangoon, and with suggestions as to the determination of the level of high water for any tide at any place between Rangoon and Elephant Point; in furnishing the Assistant Surveyor-General in charge, Map Record and Issue Office, the Officer in charge No. 24 Party, Survey of India Department, the Quarter Master General, Intelligence Branch, Rangoon, the Executive Engineer, Eastern Irrigation Division, Yamèthin, Upper Burma, and the Chief Engineer, Great Indian Peninsula Railway, Bombay, with the levels of various important bench-marks at their request; in the preparation of portions of the tidal volume, revisions and correspondence, etc.; in the collection of information with a view to preparing an Indian co-tidal chart; and in submitting reports, as before, on the tidal operations carried on in the Bombay Presidency and in Burma to the Local Governments.

State of the ordinary reductions of the yearly tidal registrations at the beginning and end of the Survey year 1892-93.

Tidal Observatory.	State at end of September 1892.	State at end of September 1893.
ADEN . . .	1891-92 calculations completed. A. P. 1891.	1890-91 calculations completed. 1892 calculations completed. A. P. 1892.
KURRACHEE . .	1891-92 calculations completed. A. P. 1891.	1892 calculations completed. A. P. 1892.
BHÁVNAGAR . .	1891 calculations completed. A. P. 1891.	1892 calculations completed. A. P. 1892.
BOMBAY (Apollo Bandar).	1891 calculations completed. A. P. 1891.	1892 calculations completed. A. P. 1892.
BOMBAY (Prince's Dock).	1891 calculations completed. A. P. 1891.	1892 calculations completed. A. P. 1892.
COCHIN (closed 20th March 1892).	1891-92 calculations completed. A. P. 1891.	A. P. 1892.
MINICOY . . .	1891-92 calculations completed.	1892-93 calculations completed.
TRINCOMALEE . .	1890-91 calculations completed.	1891 calculations completed. 1892 calculations completed.
TUTICORIN (closed 19th June 1893).	1891-92 calculations completed. A. P. 1891.	1892-93 calculations completed. A. P. 1892.
COCANADA (closed 18th April 1891).	A. P. 1891.	A. P. 1892.
KIDDERPORE . .	1891-92 calculations completed. A. P. 1891.	1892-93 calculations completed. A. P. 1892.
CHITTAGONG (closed 22nd July 1891).	A. P. 1891.	A. P. 1892.
AKYAB (closed 23rd May 1892).	1891-92 calculations completed. A. P. 1891.	A. P. 1892.
RANGOON . . .	1891-92 calculations completed. A. P. 1891.	1892 calculations completed. A. P. 1892.
MOULMEIN (closed 24th April 1886).	A. P. 1891.	A. P. 1892.
MERGUI . . .	1891-92 calculations completed. A. P. 1891.	1892-93 calculations completed. A. P. 1892.
PORT BLAIR . .	1890-91 new calculations ending October 29, 1891, necessitated by cyclone, completed. A. P. 1891.	1892-93 calculations, commencing 30th January 1892, completed. A. P. 1892.

No completed tidal diagrams were sent for safe custody to the Surveyor-General's Office during the year under report.

VALUES OF THE TIDAL CONSTANTS, ADEN, 1890-91.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1890-91 observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1890-91 observations:—

Short Period Tides.

A_0=5·780 feet.

S_1	H =	·080	M_6	R =	·006	Q_1	R =	·187	T_2	R =	·008
	R =			ζ =	112°·62		ζ =	54°·05		ζ =	168°·54
	κ =	181°·51		H =	·006		H =	·177		H =	·008
	ζ =			κ =	319°·64		κ =	52°·92		κ =	108°·51
S_2	H =	·652	M_8	R =	·003	L_2	R =	·028	$(MS)_4$	R =	·013
	R =			ζ =	294°·44		ζ =	222°·08		ζ =	74°·25
	κ =	242°·60		H =	·003		H =	·026		H =	·013
	ζ =			κ =	210°·47		κ =	315°·91		κ =	143°·26
S_4	H =	·006	O_1	R =	·677	N_2	R =	·448	$(2SM)_2$	R =	·037
	R =			ζ =	205°·78		ζ =	345°·63		ζ =	141°·86
	κ =	278°·26		H =	·642		H =	·451		H =	·037
	ζ =			κ =	35°·81		κ =	223°·48		κ =	72°·86
S_6	H =	·006	K_1	R =	1·333	λ_2	R =	...	$2N_2$	R =	·080
	R =			ζ =	151°·33		ζ =	,,		ζ =	148°·00
	κ =	193°·57		H =	1·289		H =	...		H =	·080
	ζ =			κ =	34°·00		κ =	...		κ =	194°·69
S_8	H =	·002	K_2	R =	·249	ν_2	R =	·064	$(MN)_4$	R =	·027
	R =			ζ =	290°·98		ζ =	183°·69		ζ =	155°·81
	κ =	135°·00		H =	·233		H =	·065		H =	·028
	ζ =			κ =	235°·93		κ =	154°·97		κ =	102°·66
M_1	R =	·115	P_1	R =	·343	μ_2	R =	·064	$(M_2K_1)_3$	R =	·029
	ζ =	325°·13		ζ =	276°·53		ζ =	50°·54		ζ =	327°·76
	H =	·079		H =	·343		H =	·064		H =	·028
	κ =	52°·96		κ =	25°·44		κ =	188°·56		κ =	279°·43
M_2	R =	1·553	J_1	R =	·151	R_2	R =	...	$(2M_2K_1)_3$	R =	·014
	ζ =	155°·68		ζ =	311°·15		ζ =	...		ζ =	88°·76
	H =	1·564		H =	·143		H =	...		H =	·014
	κ =	224°·68		κ =	21°·29		κ =	...		κ =	344°·11
M_3	R =	·018									
	ζ =	285°·68									
	H =	·019									
	κ =	209°·19									
M_4	R =	·008									
	ζ =	100°·86									
	H =	·008									
	κ =	238°·87									

Long Period Tides.

	R	ζ	H	κ
Lunar monthly tide . . .	·018	198°·79	·018	29°·95
,, fortnightly ,, . . .	·051	112°·83	·045	341°·79
Luni-solar ,, ,, . . .	·002	255°·12	·002	186°·11
Solar annual ,, . . .	·424	13°·98	·424	355°·07
,, semi-annual ,, . . .	·161	143°·79	·161	105°·97

VALUES OF THE TIDAL CONSTANTS, ADEN, 1892.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892 observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892 observations:—

Short Period Tides.

A_0=5·836 feet.

S_1	H =	·091	M_6	R =	·004	Q_1	R =	·164	T_2	R =	·058
	R =			ζ =	120°·38		ζ =	191°·38		ζ =	292°·16
	κ =	186°·18		H =	·004		H =	·143		H =	·058
	ζ =			κ =	355°·56		κ =	35°·46		κ =	292°·76
S_2	H =	·660	M_8	R =	·004	L_1	R =	·032	$(MS)_4$	R =	·017
	R =			ζ =	311°·01		ζ =	162°·67		ζ =	216°·24
	κ =	244°·08		H =	·004		H =	·046		H =	·081
	ζ =			κ =	144°·58		κ =	214°·16		κ =	174°·63
S_4	H =	·010									
	R =										
	κ =	269°·76									
	ζ =										
S_6	H =	·005									
	R =										
	κ =	198°·44									
	ζ =										

Short Period Tides—contd.

A_0=7·243 feet.

S_8	H =		·002	O_1	R =		·743	N_2	R =		·414	$(2SM)_2$	R =		·013
	R =				ζ =	260°·64			ζ =	194°·30			ζ =	59°·51
	κ =	ζ =	312°·27		H =		·651		H =		·425		H =		·013
					κ =	36°·35			κ =	221°·05			κ =	101°·12
M_1	R =		·133	K_1	R =		1·426	λ_2	R =		...	$2N_2$	R =		·095
	ζ =	122°·07			ζ =	209°·01			ζ =	...			ζ =	94°·46
	H =		·062		H =		1·311		H =		...		H =		·098
	κ =		22°·90		κ =		33°·96		κ =		...		κ =		189°·57
M_2	R =		1·519	K_2	R =		·230	ν_2	R =		·136	$(MtN)_4$	R =		·028
	ζ =	266°·93			ζ =	48°·11			ζ =	358°·72			ζ =	226°·35
	H =		1·560		H =		·187		H =		·140		H =		·030
	κ =		225°·32		κ =		237°·45		κ =		208°·65		κ =		211°·50
M_3	R =		·012	P_1	R =		·423	μ_2	R =		·068	$(M_2K_1)_3$	R =		·034
	ζ =	258°·50			ζ =	221°·86			ζ =	267°·79			ζ =	172°·59
	H =		·012		H =		·423		H =		·072		H =		·032
	κ =		196°·08		κ =		31°·38		κ =		184°·58		κ =		315°·93
M_4	R =		·009	J_1	R =		·153	R_2	R =		...	$(2M_2K_1)_3$	R =		·015
	ζ =		6°·19		ζ =	288°·10			ζ =		...		ζ =	250°·82
	H =		·009		H =		·135		H =		...		H =		·015
	κ =		282°·97		κ =		42°·42		κ =		...		κ =		342°·66

Long Period Tides.

	R	ζ	H	κ
Lunar monthly tide	·040	246°·52	·044	178°·16
,, fortnightly ,,	·056	146°·90	·042	13°·86
Luni-solar ,, ,,	·017	258°·05	·017	299°·66
Solar annual ,,	·332	81°·98	·332	2°·46
,, semi-annual ,,	·145	274°·50	·145	115°·48

Values of the Tidal Constants, Kurrachee, 1892.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892 observations at Kurrachee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892 observations:—

Short Period Tides.

A_0=7·243 feet.

S_1	H =		·104	M_6	R =		·046	Q_1	R =		·170	T_2	R =		·067
	R =				ζ =	315°·49			ζ =	200°·05			ζ =	10°·25
	κ =	ζ =	190°·78		H =		·050		H =		·149		H =		·067
S_2	H =		·956		κ =		195°·10		κ =		46°·47		κ =		10°·91
	R =			M_8	R =		·007	L_2	R =		·054	$(MS)_4$	R =		·032
	κ =	ζ =	324°·39		ζ =		26°·57		ζ =	234°·77			ζ =	5°·38
S_4	H =		·013		H =		·007		H =		·079		H =		·033
	R =				κ =		226°·05		κ =		286°·96		κ =		325°·25
	κ =	ζ =	14°·37	O_1	R =		·753	N_2	R =		·597	$(2SM)_2$	R =		·018
S_6	H =		·009		ζ =		269°·41		ζ =	250°·12			ζ =	82°·38
	R =				H =		·659		H =		·614		H =		·018
	κ =	ζ =	302°·78		κ =		46°·66		κ =		279°·15		κ =		122°·51
S_8	H =		·001	K_1	R =		1·437	λ_2	R =		...	$2N_2$	R =		·095
	R =				ζ =		221°·33		ζ =		...		ζ =	155°·65
	κ =	ζ =	142°·13		H =		1·321		H =		...		H =		·098
M_1	R =		·133		κ =		46°·22		κ =		...		κ =		253°·83
	ζ =	138°·22		K_2	R =		·326	ν_2	R =		·179	$(M_2N)_4$	R =		·046
	H =		·062		ζ =		128°·20		ζ =	44°·95			ζ =	271°·81
	κ =		39°·80		H =		·265		H =		·184		H =		·049
M_2	R =		2·534		κ =		317°·42		κ =	257°·05			κ =	260°·71	
	ζ =	333°·77													
	H =		2·603												
	κ =		293°·64												

Short Period Tides—contd.

A_0=7·234 feet.

M_3	R =	·025	P_1	R =	·422	μ_2	R =	·047	$(MK)_3$	R =	·053
	ζ =	46°·00		ζ =	233°·74		ζ =	355°·06		ζ =	242°·25
	H =	·026		H =	·422		H =	·050		H =	·050
	κ =	345°·81		κ =	43°·31		κ =	274°·81		κ =	27°·01
M_4	R =	·038	J_1	R =	·150	R_2	R =	...	$(2M_2K_1)_3$	R =	·032
	ζ =	65°·42		ζ =	302°·97		ζ =	...		ζ =	289°·07
	H =	·040		H =	·133		H =	...		H =	·031
	κ =	345°·17		κ =	56°·43		κ =	...		κ =	23°·92

Long Period Tides.

	R	ζ	H	κ
Lunar monthly tide	·017	56°·02	·019	346°·87
fortnightly „	·059	181°·89	·044	47°·24
Luni-solar „ „	·048	303°·48	·049	343°·61
Solar-annual „	·190	173°·20	·190	93°·63
„ semi-annual „	·171	306°·68	·171	147°·54

Values of the Tidal Constants, Bhavnagar, 1892.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892 observations at Bhavnagar; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892 observations:—

Short Period Tides.

A_0=22·699 feet.

S_1	H = R =	·107	M_6	R =	·252	Q_1	R =	·259	T_2	R =	·478
	κ = ζ =	213°·53		ζ =	250°·74		ζ =	235°·39		ζ =	187°·41
S_2	H = R =	3·522		H =	·273		H =	·227		H =	·478
	κ = ζ =	177°·07		κ =	131°·43		κ =	82°·37		κ =	188°·08
S_4	H = R =	·121	M_8	R =	·005	L_2	R =	·530	$(MS)_4$	R =	·598
	κ = ζ =	236°·39		ζ =	90°·53		ζ =	67°·39		ζ =	238°·52
S_6	H = R =	·021		H =	·006		H =	·774		H =	·614
	κ = ζ =	307°·52		κ =	291°·45		κ =	119°·75		κ =	198°·75
S_8	H = R =	·001	O_1	R =	1·112	N_2	R =	2·410	$(2SM)_2$	R =	·084
	κ = ζ =	56°·31		ζ =	307°·74		ζ =	86°·86		ζ =	301°·38
				H =	·974		H =	2·475		H =	·086
				κ =	85°·37		κ =	116°·43		κ =	341°·15
M_1	R =	·269	K_1	R =	2·573	λ_2	R =	...	$2N_2$	R =	·262
	ζ =	184°·68		ζ =	265°·45		ζ =	...		ζ =	309°·13
	H =	·125		H =	2·365		H =	...		H =	·270
	κ =	86°·44		κ =	90°·32		κ =	...		κ =	48°·05
M_2	R =	10°·980	K_2	R =	1·210	ν_2	R =	·867	$(M_2N)_4$	R =	·173
	ζ =	173°·45		ζ =	341°·45		ζ =	240°·34		ζ =	107°·36
	H =	11·278		H =	·984		H =	·890		H =	·183
	κ =	133°·68		κ =	170°·64		κ =	92°·96		κ =	97°·17
M_3	R =	·063	P_1	R =	·688	μ_2	R =	·305	(M_2K_1)	R =	·286
	ζ =	314°·21		ζ =	283°·79		ζ =	339°·26		ζ =	357°·62
	H =	·066		H =	·688		H =	·322		H =	·270
	κ =	254°·56		κ =	93°·37		κ =	259°·72		κ =	142°·72
M_4	R =	·842	J_1	R =	·242	R_2	R =	...	(2_2MK)	R =	·163
	ζ =	229°·92		ζ =	4°·98		ζ =	...		ζ =	243°·81
	H =	·888		H =	·214		H =	...		H =	·158
	κ =	150°·38		κ =	118°·24		κ =	...		κ =	339°·39

Long Period Tides.

	R	ζ	H	κ
Lunar monthly tide	·133	63°·89	·147	345°·54
„ fortnightly „	·083	154°·93	·062	19°·90
Luni-solar „ „	·123	347°·63	·126	17°·40
Solar annual „ . . .	·359	190°·91	·359	111°·32
„ semi-annual „	·131	296°·73	·131	137°·5

Values of the Tidal Constants, Bombay, 1892.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892 observations at Bombay; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892 observations:—.

Short Period Tides.

A_0=10·285 feet.

S_1	H=R=	·081	M_6	R=	·012	Q_1	R=	·168	T_2	R=	·237
	κ= ζ=	206°·66		ζ=	203°·13		ζ=	202°·27		ζ=	16°·62
S_2	H=R=	1·576		H=	·013		H=	·147		H=	·237
	κ= ζ=	5°·15		κ=	83°·97		κ=	49°·32		κ=	17°·30
S_4	H=R=	·016	M_8	R=	·002	L_2	R=	·026	$(MS)_4$	R=	·137
	κ= ζ=	148°·23		ζ=	188°·53		ζ=	253°·56		ζ=	80°·59
S_6	H=R=	·004		H=	·003		H=	·038		H=	·141
	κ= ζ=	162°·41		κ=	29°·64		κ=	305°·94		κ=	40°·87
S_8	H=R=	·003	O_1	R=	·752	N_2	R=	·948	$(2SM)_2$	R=	·045
	κ= ζ=	115°·56		ζ=	270°·74		ζ=	286°·12		ζ=	63°·78
				H=	·659		H=	·974		H=	·047
				κ=	48°·42		κ=	315°·76		κ=	103°·50
M_1	R=	·149	K_1	R=	1·532	λ_2	R=	...	$2N_2$	R=	·177
	ζ=	135°·98		ζ=	220°·96		ζ=	...		ζ=	205°·24
	H=	·069		H=	1·408		H=	...		H=	·182
	κ=	37°·76		κ=	45°·83		κ=	...		κ=	304°·25
M_2	R=	3·931	K_2	R=	·515	υ_2	R=	·250	$(M_2N)_4$	R=	·054
	ζ=	10°·77		ζ=	165°·86		ζ=	76°·87		ζ=	321°·11
	H=	4·038		H=	·418		H=	·257		H=	·056
	κ=	331°·05		κ=	355°·05		κ=	289°·56		κ=	311°·04
M_3	R=	·055	P_1	R=	·424	μ_2	R=	·185	$(M_2K_1)_3$	R=	·050
	ζ=	77°·81		ζ=	235°·41		ζ=	25°·89		ζ=	323°·32
	H=	·057		H=	·424		H=	·195		H=	·047
	κ=	18°·23		κ=	45°·00		κ=	306°·45		κ=	108°·47
M_4	R=	·139	J_1	R=	·161	R_2	R=	...	$(2M_2K_1)_3$	R=	·090
	ζ=	55°·72		ζ=	304°·86		ζ=	...		ζ=	347°·89
	H=	·146		H=	·142		H=	...		H=	·087
	κ=	336°·28		κ=	58°·09		κ=	..		κ=	83°·58

Long Period Tides.

	R	ζ	H	κ
Lunar monthly tide	·064	339°·29	·071	269°·93
„ fortnightly „	·066	138°·97	·049	3°·89
Luni-solar „ „	·055	269°·15	·056	308°·88
Solar arnnual „	·076	199°·62	·076	120°·03
„ semi-annual „	·132	340°·59	·132	181°·42

Values of the Tidal Constants, Prince's Dock, 1892.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892 observations at Prince's Dock; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892 observations:—

Short Period Tides.

A_0=8·347 feet.

S_1	H=R=	·092	M_6	R=	·010	Q_1	R=	·166	T_2	R=	·243
	κ=ζ=	200°·59		ζ=	242°·04		ζ=	201°·96		ζ=	12°·34
S_2	H=R=	1·614		H=	·011		H=	·145		H=	·243
	κ=ζ=	4°·14		κ=	122°·87		κ=	49°·01		κ=	13°·02
S_4	H=R=	·017	M_8	R=	·004	L_2	R=	·031	$(MS)_4$	R=	·116
	κ=ζ=	176°·06		ζ=	233°·47		ζ=	225°·67		ζ=	73°·39
S_6	H=R=	·003		H=	·005		H=	·045		H=	·119
	κ=ζ=	185°·53		κ=	74°·58		κ=	278°·05		κ=	33°·66
S_8	H=R=	·002	O_1	R=	·746	N_2	R=	·966	$(2SM)_2$	R=	·055
	κ=ζ=	81°·03		ζ=	270°·08		ζ=	285°·23		ζ=	64°·96
				H=	·654		H=	·993		H=	·056
				κ=	47°·76		κ=	314°·88		κ=	104°·68
M_1	R=	·151	K_1	R=	1·527	λ_2	R=	...	$2N_2$	R=	·180
	ζ=	135°·03		ζ=	220°·06		ζ=	...		ζ=	205°·02
	H=	·070		H=	1·404		H=	...		H=	·185
	κ=	36°·80		κ=	44°·93		κ=	...		κ=	304°·04
M_2	R=	4·003	K_2	R=	·518	υ_2	R=	·250	$(M_2N)_4$	R=	·050
	ζ=	9°·10		ζ=	165°·23		ζ=	76°·90		ζ=	329°·02
	H=	4·112		H=	·421		H=	·257		H=	0·53
	κ=	329°·38		κ=	354°·41		κ=	289°·59		κ=	318°·94
M_3	R=	·065	P	R=	·423	μ_2	R=	·193	$(M_3K_1)_3$	R=	·034
	ζ=	77°·10		ζ=	234°·64		ζ=	28°·82		ζ=	308°·28
	H=	·068		H=	·423		H=	·204		H=	·032
	κ=	17°·52		κ=	44°·22		κ=	309°·38		κ=	93°·43
M_4	R=	·122	J_1	R=	·166	R_2	R=	...	$(2M_2K_1)_3$	R=	·084
	ζ=	45°·73		ζ=	304°·17		ζ=	...		ζ=	343°·97
	H=	·128		H=	·146		H=	...		H=	·081
	κ=	326°·29		κ=	57°·40		κ=	...		κ=	79°·65

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·063	343°·78	·069	274°·41
„ Fortnightly „	·073	140°·92	·055	5°·83
Luni-Solar „ „	·048	285°·26	·049	324°·98
Solar-Annual „	·057	211°·95	·057	132°·36
„ Semi-Annual „	·134	335°·34	·134	176°·16

Values of the Tidal Constants, Minicoy, 1892-93.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892-93 observations at Minicoy; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892-93 observations:—

Short Period Tides.

A_0=5·269 feet.

S_1	H= R=	·061	M_6	R=	·001	Q_1	R=	·062	T_2	R=	·034
	κ= ζ=	198° 35		ζ=	243°·44		ζ=	276°·11		ζ=	331°·93
S_2	H= R=	·332		H=	·001		H=	·055		H=	·034
	κ= ζ=	21°·74		κ=	39°·77		κ=	60°·35		κ=	321°·76
S_4	H= R=	·001	M_8	R=	·003	L_2	R=	·028	$(MS)_4$	R=	·011
	κ= ζ=	12°·10		ζ=	36°·39		ζ=	87°·47		ζ=	247°·17
S_6	H= R=	·001		H=	·003		H=	·039		H=	·011
	κ= ζ=	291°·80		κ=	244°·83		κ=	14°·84		κ=	299°·28

Short Period Tides—contd.

$A^{\circ}=5{\cdot}836$ feet.

S_8	H =	R =	·001	O_1	R =	·373	N_2	R =	·167	$(2SM)_2$	R =	·004
	κ =	ζ =	145°·01		ζ =	201°·11		ζ =	326°·61		ζ =	7°·50
					H =	·327		H =	·172		H =	·004
					κ =	59°·70		κ =	304°·38		κ =	315°·38
M_1	R =		·043	K_1	R =	·742	λ_2	R =	…	$2N_2$	R =	·013
	ζ =		269°·33		ζ =	216°·46		ζ =	…		ζ =	336°·57
	H =		·020		H =	·682		H =	…		H =	·014
	κ =		37°·76		κ =	52°·24		κ =	…		κ =	240°·01
M_2	R =		·813	K_2	R =	·115	ν_2	R =	·069	$(M_2N)_4$	R =	·048
	ζ =		279°·86		ζ =	173°·41		ζ =	103°·59		ζ =	231°·15
	H =		·835		H =	·093		H =	·071		H =	·051
	κ =		331°·97		κ =	24°·41		κ =	283°·64		κ =	261°·03
M_3	R =		·003	P_1	R =	·226	μ_2	R =	·015	$(M_2K_1)_3$	R =	·006
	ζ =		290°·14		ζ =	247°·03		ζ =	168°·92		ζ =	348°·28
	H =		·003		H =	·226		H =	·016		H =	·005
	κ =		188°·30		κ =	45°·78		κ =	273°·15		κ =	236°·16
M_4	R =		·004	J_1	R =	·040	R_2	R =	…	$(2M_2K_1)_3$	R =	·005
	ζ =		66°·37		ζ =	174°·33		ζ =	…		ζ =	354°·81
	H =		·004		H =	·035		H =	..		H =	·004
	κ =		170°·60		κ =	82°·20		κ =	…		κ =	263°·25

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·035	72°·63	·039	146°·97
„ Fortnightly „	·073	202°·09	·054	357°·04
Luni-Solar „ „	·016	102°·04	·016	49°·93
Solar-Annual „	·283	66°·98	·283	358°·24
„ Semi-Annual „	·170	6°·35	·170	228°·86

Values of the Tidal Constants, Trincomalee, 1891.

The following are amplitudes (R) and epochs (ζ) deduced from the 1891 observations at Trincomalee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1891 observations:—

Short Period Tides.

$A_0=1{\cdot}826$ feet.

S_1	H =	R =	·020	M_6	R =	·005	Q_1	R =	·010	T_2	R =	·056
	κ =	ζ =	64°·86		ζ =	176°·50		ζ =	355°·01		ζ =	187°·11
S_2	H =	R =	·192		H =	·006		H =	·009		H =	·056
	κ =	ζ =	264°·50		κ =	115°·51		κ =	192°·95		κ =	187°·56
S_4	H =	R =	·006	M_8	R =	·003	L_2	R =	·041	$(MS)_4$	R =	·013
	κ =	ζ =	258°·89		ζ =	284°·04		ζ =	75°·45		ζ =	338°·54
S_6	H =	R =	·001		H =	·003		H =	·058		H =	·013
	κ =	ζ =	48°·37		κ =	82°·72		κ =	332°·51		κ =	198°·21
S_8	H =	R =	·001	O_1	R =	·070	N_2	R =	·144	$(2SM)_2$	R =	·007
	κ =	ζ =	336°·80		ζ =	268°·77		ζ =	206°·69		ζ =	91°·64
					H =	·064		H =	·147		H =	·007
					κ =	308°·31		κ =	224°·76		κ =	231°·97
M_1	R =		·015	K_1	R =	·224	λ_2	R =	…	$2N_2$	R =	·019
	ζ =		14°·88		ζ =	148°·36		ζ =	…		ζ =	18°·91
	H =		·007		H =	·211		H =	…		H =	·020
	κ =		23°·99		κ =	331°·61		κ =	…		κ =	195°·37
M_2	R =		581	K_2	R =	·090	ν_2	R =	·053	$(M_2N)_4$	R =	·007
	ζ =		22°·41		ζ =	78°·43		ζ =	322°·30		ζ =	7°·54
	H =		·591		H =	·079		H =	·054		H =	·007
	κ =		242°·08		κ =	264° 36		κ =	245°·16		κ =	245°·28

Short Period Tides—contd.

A_0=1·826 feet.

M_3	R =	·001	P_1	R =	·076	μ_2	R =	·036	$(M_2K_1)_3$	R =	·005
	ζ =	11°·31		ζ =	170°·84		ζ =	86°·57		ζ =	170°·54
	H =	·001		H =	·076		H =	·037		H =	·005
	κ =	340°·82		κ =	340°·21		κ =	165°·91		κ =	213°·45
M_4	R =	·012	J_1	R =	·021	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	179°·48		ζ =	251°·31		ζ =	...		ζ =	118°·01
	H =	·012		H =	·019		H =	...		H =	·005
	κ =	258°·82		κ =	273°·03		κ =	...		κ =	14°·11

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·029	137°·08	·031	338°·68
„ Fortnightly „ . . .	·061	58·96	·050	19·54
Luni-Solar „ . . .	·012	126·13	·012	266·46
Solar-Annual „ . . .	·266	7·17	·266	287·80
„ Semi-Annual „ . . .	·165	298·44	·165	139·70

Values of the Tidal Constants, Trincomalee, 1892.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892 observations at Trincomalee, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892 observations:—

Short Period Tides.

A_0=2·043 feet.

S_1	H = R =	·015	M_6	R =	·002	Q_1	R =	·016	T_2	R =	·050
	κ = ζ =	55°·11		ζ =	230°·19		ζ =	4°·44		ζ =	238°·56
S_2	H = R =	·208		H =	·002		H =	·009		H =	·050
	κ = ζ =	266°·49		κ =	112°·73		κ =	212°·39		κ =	239°·26
S_4	H = R =	·003	M_8	R =	·001	L_2	R =	·046	$(MS)_4$	R =	·010
	κ = ζ =	272°·05		ζ =	11°·31		ζ =	196°·14		ζ =	251°·57
S_6	H = R =	·001		H =	·001		H =	·067		H =	·011
	κ = ζ =	167°·47		κ =	214°·69		κ =	248°·78		κ =	212°·41
S_8	H = R =	·000	O_1	R =	·073	N_2	R =	·124	$(2SM)_2$	R =	0·24
	κ = ζ =	26°·57		ζ =	169°·12		ζ =	195°·78		ζ =	209°·08
				H =	·064		H =	·127		H =	·024
				κ =	307°·40		κ =	226°·30		κ =	248°·23
M_1	R =	·012	K_1	R =	·232	λ_2	R =	...	$2N_2$	R =	·041
	ζ =	43°·68		ζ =	146°·12		ζ =	...		ζ =	138°·27
	H =	·006		H =	·213		H =	...		H =	·043
	κ =	305°·74		κ =	330°·97		κ =	...		κ =	238°·47
M_2	R =	·605	K_2	R =	·079	ν_2	R =	·058	(M_2N_4)	R =	·026
	ζ =	277°·02		ζ =	76°·19		ζ =	346°·77		ζ =	93°·18
	H =	·621		H =	·065		H =	·059		H =	·028
	κ =	237°·86		κ =	265°·33		κ =	200°·29		κ =	84°·55
M_3	R =	·005	P_1	R =	·068	μ_2	R =	·037	$(M_2K_1)_3$	R =	·008
	ζ =	183°·65		ζ =	160°·41		ζ =	241°·59		ζ =	135°·00
	H =	·005		H =	·068		H =	·039		H =	·008
	κ =	124°·92		κ =	330°·02		κ =	163°·28		κ =	280°·69
M_4	R =	·008	J_1	R =	·013	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	316°·58		ζ =	188°·01		ζ =	...		ζ =	44°·17
	H =	·009		H =	·011		H =	...		H =	·005
	κ =	238°·27		κ =	300°·91		κ =	...		κ =	141°·01

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide. . . .	·061	205°·29	·067	136°·61
„ Fortnightly „ . . .	·074	139°·96	·055	4°·26
Luni-Solar „ „ . . .	·009	198°·02	·009	237°·18
Solar-Annual „ . . .	·255	310°·85	·255	231°·24
„ Semi-Annual „ . . .	·169	281°·52	·169	112°·30

Values of the Tidal Constants, Tuticorin, 1892-93.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892-93 observations at Tuticorin ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892-93 observations :—

Short Period Tides.

A_0=2·187 feet.

S_1	H = R =	·054	M_6	R =	·016	Q_1	R =	·628		R =	·032
	κ = ζ =	63°·77		ζ =	166°·76		ζ =	4°·12	T_2	ζ =	227°·60
S_2	H = R =	·467		H =	·017		H =	·024		H =	·032
	κ = ζ =	83°·77		κ =	18°·26		κ =	90°·55		κ =	77°·50
S_4	H = R =	·007	M_8	R =	·008	L_2	R =	·030	$(MS)_4$	R =	·016
	κ = ζ =	232°·13		ζ =	220°·24		ζ =	294°·60		ζ =	67°·56
S_6	H = R =	·010		H =	·009		H =	·033		H =	·016
	κ = ζ =	152°·91		κ =	262°·24		κ =	53°·49		κ =	258°·06
S_8	H = R =	·012	O_1	R =	·142	N_2	R =	·076	$(2SM)_2$	R =	·007
	κ = ζ =	223°·24		ζ =	191°·56		ζ =	333°·30		ζ =	109°·25
				H =	·123		H =	·078		H =	·007
				κ =	47°·38		κ =	34°·42		κ =	278°·75
M_1	R =	·020	K_1	R =	·324	λ_2	R =	...	$2N_2$	R =	·003
	ζ =	253°·53		ζ =	49°·63		ζ =	...		ζ =	194°·93
	H =	·010		H =	·296		H =	...		H =	·003
	κ =	101°·99		κ =	26°·20		κ =	...		κ =	126°·67
M_2	R =	·642	K_2	R =	·164	ν_2	R =	·009	$(M_2N)_4$	R =	·009
	ζ =	212°·80		ζ =	311°·19		ζ =	203°·82		ζ =	162°·18
	H =	·662		H =	·130		H =	·009		H =	·010
	κ =	43°·30		κ =	83°·83		κ =	355°·47		κ =	53°·80
M_3	R =	0·19	P_1	R =	·070	μ_2	R =	·020	$(M_2K_1)_3$	R =	·007
	ζ =	56°·73		ζ =	349°·65		ζ =	77°·89		ζ =	300°·07
	H =	·020		H =	·070		H =	·021		H =	·006
	κ =	162°·48		κ =	8°·45		κ =	98°·89		κ =	107°·14
M_4	R =	0·25	J_1	R =	·014	R_2	R =	...	$(2M_2K_1)_3$	R =	·003
	ζ =	137°·58		ζ =	322°·97		ζ =	...		ζ =	173° 09
	H =	·026		H =	·013		H =	...		H =	·003
	κ =	158°·58		κ =	67°·04		κ =	...		κ =	217°·52

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	.049	253°·37	·055	22°·75
„ Fortnightly „ . . .	·048	73°·92	·035	12°·80
Luni-Solar „ „ . . .	·033	292°·30	·034	101°·80
Solar-Annual „ . . .	·327	239°·12	·327	310°·32
„ Semi-Annual „ . . .	·107	322°·03	·107	104°·44

Values of the Tidal Constants, Kidderpore, 1892-93.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892-93 observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892-93 observations:—

Short Period Tides.

A_0=10·817 feet.

S_1	H = R =	·093	M_6	R =	·147	Q_1	R =	·036	T_2	R =	·211
	κ = ζ =	191°·47		ζ =	228°·94		ζ =	30°·69		ζ =	242°·63
S_2	H = R =	1·543		H =	·161		H =	·031		H =	·211
	κ = ζ =	96°·62		κ =	308°·57		κ =	5°·83		κ =	163°·51
S_4	H = R =	·097	M_8	R =	·077	L_2	R =	·167	$(MS)_4$	R =	·682
	κ = ζ =	100°·72		ζ =	155°·74		ζ =	207°·33		ζ =	287°·75
S_6	H = R =	·007		H =	·086		H =	·208		H =	·702
	κ = ζ =	34°·16		κ =	21°·91		κ =	61°·07		κ =	74°·29
S_8	H = R =	·002	O_1	R =	·251	N_2	R =	·667	$(2SM)_2$	R =	·088
	κ = ζ =	352°·88		ζ =	137°·29		ζ =	158°·05		ζ =	164°·89
				H =	·218		H =	·686		H =	·090
				κ =	20°·76		κ =	36°·26		κ =	18°·35
M_1	R =	·027	K_1	R =	·434	λ_2	R =	...	$2N_2$	R =	·076
	ζ =	148°·22		ζ =	147°·56		ζ =	...		ζ =	38°·84
	H =	·013		H =	·397		H =	...		H =	·078
	κ =	148°·86		κ =	52°·69		κ =	...		κ =	8°·72
M_2	R =	3·620	K_2	R =	·617		R =	·162	$(M_2N)_4$	R =	·134
	ζ =	268°·69		ζ =	101°·22		ζ =	198°·99		ζ =	245°·96
	H =	3·726		H =	·495		H =	·166		H =	·142
	κ =	55°·23		κ =	90°·96		κ =	41°·79		κ =	270°·71
M_3	R =	·036	P_8	R =	·135	μ_2	R =	·215	$(M_2K_1)_3$	R =	·095
	ζ =	152°·20		ζ =	221°·18		ζ =	248°·74		ζ =	358°·27
	H =	·038		H =	·135		H =	·228		H =	·090
	κ =	12°·02		κ =	310°·97		κ =	181°·82		κ =	49°·95
M_4	R =	·723	J_1	R =	·025	R_2	R =	...	$(2M_2K_1)_3$	R =	·050
	ζ =	99°·43		ζ =	238°·12		ζ =	...		ζ =	289°·17
	H =	·766		H =	·022		H =	...		H =	0·48
	κ =	32°·51		κ =	49°·52		κ =	...		κ =	317°·12

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·318	83°·71	·353	352° 04
„ Fortnightly „	·325	204°·18	·239	43° 77
Luni-Solar „ „	·956	187°·06	·984	40°·52
Solar-Annual „	2·650	151°·98	2·650	152°·19
„ Semi-Annual „	·970	351°·15	·970	351°·57

Values of the Tidal Constants, Rangoon, 1892.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892 observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892 observations:—

Short Period Tides.

A_0=10·354 feet.

S_1	H = R =	·087	M_6	R =	·210	Q_1	R =	·032	T_2	R =	·289
	κ = ζ =	129°·52		ζ =	193°·90		ζ =	142°·67		ζ =	180°·34
S_2	H = R =	2·170		H =	·228		H =	·028		H =	·289
	κ = ζ =	168°·68		κ =	79°·47		κ =	352°·21		κ =	181°·08

Short Period Tides—contd.

A_0=10·354 feet.

S_4	H=	·085	M_8	R=	·091	L_2	R=	·508	$(MS)_4$	R=	·361
	R=			ζ=	231°·82		ζ=	81°·90		ζ=	248°·19
	κ=	260°·76		H=	·101		H=	·742		H=	·371
	ζ=			κ=	79°·24		κ=	135°·01		κ=	210°·04
S_6	H=	·010	O_1	R=	·311	N_2	R=	1°·101	$(2SM)_2$	R=	·189
	R=			ζ=	241°·17		ζ=	86°·67		ζ=	3°·16
	κ=	22°·13		H=	·273		H=	1·131		H=	·194
	ζ=			κ=	20°·50		κ=	118°·74		κ=	41°·31
S_8	H=	·003	K_1	R=	·746	λ_2	R=	…	$2N_2$	R=	·193
	R=			ζ=	207°·60		ζ=	…		ζ=	298°·14
	κ=	6°·34		H=	·686		H=	…		H=	·198
	ζ=			κ=	32°·41		κ=	…		κ=	40°·43
M_1	R=	·030	K_2	R=	·792	ν_2	R=	·425	$(M_2N)_4$	R=	·101
	ζ=	132°·44		ζ=	333°·49		ζ=	246°·15		ζ=	107°·21
	H=	·014		H=	·644		H=	·437		H=	·106
	κ=	35°·00		κ=	162°·55		κ=	101°·15		κ=	101°·14
M_2	R=	5·868		R=	·208	μ_2	R=	·474	$(M^2K^1)_3$	R=	·128
	ζ=	168°·07		ζ=	246°·56		ζ=	5°·69		ζ=	314°·77
	H=	6·027		H=	·208		H=	·500		κ=	·121
	κ=	129°·92		κ=	56°·21		κ=	289°·40		H=	101°·44
M_3	R=	·039	J_1	R=	·054	R_2	R=	…	$(2M^2K^1)_3$	R=	·127
	ζ=	201°·44		ζ=	304°·19		ζ=	…		ζ=	309°·68
	H=	·041		H=	·048		H=	…		H=	·123
	κ=	144°·22		κ=	56°·51		κ=	…		κ=	48°·58
M_4	R=	·400									
	ζ=	240°·41									
	H=	·422									
	κ=	164°·12									

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·139	68°·41	·153	358°·19
,, Fortnightly ,, . . .	·213	182°·64	·159	45°·84
Luni-Solar ,, ,, . . .	·424	3°·42	·435	41°·56
Solar-Annual ,, . . .	1·263	227°·14	1·263	147°·49
,, Semi-Annual ,, . . .	·203	151°·73	·203	352°·42

Values of the Tidal Constants, Mergui, 1892-93.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892-93 observations at Mergui ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892-93 observations :—

Short Period Tides.

A_0=12·999 feet.

S_1	H=	·076	M_6	R=	·062	Q_1	R=	·037	T_2	R=	·306
	R=			ζ=	79°·93		ζ=	285°·57		ζ=	83°·26
	κ=	60°·09		H=	·067		H=	·033		H=	·306
	ζ=			κ=	234°·78		κ=	300°·24		κ=	5°·16
S_2	H=	2·921	M_8	R=	·014	L_2	R=	·169	$(MS)_4$	R=	·150
	R=			ζ=	92°·43		ζ=	22°·07		ζ=	353°·71
	κ=	349°·18		H=	·016		H=	·210		H=	·155
	ζ=			κ=	58°·90		κ=	247°·46		κ=	165°·33
S_4	H=	·043	O_1	R=	·240	N_2	R=	·966	$(2SM)_2$	R=	·162
	R=			ζ=	43°·20		ζ=	29°·50		ζ=	301°·23
	κ=	222°·36		H=	·208		H=	·994		H=	·167
	ζ=			κ=	312°·78		κ=	306°·22		κ=	129°·62
S_6	H=	·015	K_1	R=	·579	λ	R=	…	$2N_2$	R=	·117
	R=			ζ=	69°·64		ζ=	…		ζ=	307°·29
	κ=	123°·58		H=	·530		H=	…		H=	·120
	ζ=			κ=	333°·76		κ=	…		κ=	329°·11
S_8	H=	·004									
	R=										
	κ=	226°·08									
	ζ=										
M_1	R=	·002									
	ζ=	324°·58									
	H=	·011									
	κ=	337°·68									

Short Period Tides—contd.

A_o=12·999 feet.

M_2	R =	5·340	K_2	R =	1·063	ν_2	R =	·217	$(M_2N)_4$	R =	·107
	ζ =	138°·74		ζ =	353°·40		ζ =	108°·53		ζ =	66°·16
	H =	5·495		H =	·854		H =	·224		H =	·113
	κ =	310°·35		κ =	341°·10		κ =	348°·04		κ =	154°·50
M_3	R =	·061	P_1	R =	·151	μ_2	R =	·436	$(M_2K_1)_3$	R =	·047
	ζ =	234°·17		ζ =	246°·02		ζ =	1°·30		ζ =	357°·63
	H =	·064		H =	·151		H =	·462		H =	·044
	κ =	131°·60		κ =	336°·82		κ =	344°·54		κ =	73°·36
M_4	R =	·118	J_1	R =	·035	R_2	R =	...	$(2N_2K_1)_3$	R =	·021
	ζ =	148.°08		ζ =	164°·24		ζ =	...		ζ =	78°·69
	H =	·125		H =	·031		H =	...		H =	·020
	κ =	131°·32		κ =	321°·18		κ =	...		κ =	157°·81

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·064	84°·69	·071	339°·50
„ Fortnightly „ . . .	·086	232°·43	·063	44°·91
Luni-Solar „ „ . . .	·043	209°·28	·044	37°·66
Solar-Annual „ . . .	·645	142°·15	·645	141°·34
„ Semi-Annual „ . . .	·200	77°·33	·200	75°·71

Values of the Tidal Constants, Port Blair, 1892-93.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1892-93 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1892-93 observations :—

Short Period Tides.

A_o=4·811 feet.

S_1	H = R =	·021	M_6	R =	·003	Q_1	R =	·028	T_2	R =	·054
	κ = ζ =	81°·60		ζ =	74°·58		ζ =	87°·29		ζ =	265°·72
S_2	H = R =	·965		H =	·004		H =	·024		H =	·054
	κ = ζ =	315°·12		κ =	358°·39		κ =	261°·74		κ =	237°·86
S_4	H = R =	·006	M_8	R =	·004	L_2	R =	·059	$(MS)_4$	R =	·0148
	κ = ζ =	295°·25		ζ =	210°·96		ζ =	201°·06		ζ =	267°·85
S_6	H = R =	·001		H =	·005		H =	·082		H =	·418
	κ = ζ =	7°·13		κ =	109°·38		κ =	284°·61		κ =	242°·28
S_8	H = R =	·002	O_1	R =	·181	N_2	R =	·398	$(2SM)_2$	R =	·058
	κ = ζ =	52°·13		ζ =	179°·43		ζ =	249°·94		ζ =	144°·29
M_1	R =	·024		H =	·158		H =	·409		H =	·098
	ζ =	30°·05		κ =	302°·67		κ =	275°·75		κ =	169°·68
	H =	·011	K_1	R =	·433	λ_2	R =	...	$2N_2$	R =	·073
	κ =	300°·96		ζ =	113°·17		ζ =	...		ζ =	192°·70
M_2	R =	1·959		H =	·397		H =	...		H =	·0
	ζ =	304°·95		κ =	326°·74		κ =	...		κ =	269°·75
	H =	2·013	K_2	R =	·341	ν_2	R =	·139	$(M_2N)_4$	R =	·069
	κ =	279°·55		ζ =	62°·11		ζ =	9°·55		ζ =	244°·44
M_3	R =	·007		H =	·276		H =	·143		H =	·073
	ζ =	39°·17		κ =	308°·69		κ =	269°·01		κ =	244°·86
	H =	·008	P_1	R =	·132	μ_2	R =	·076	(M^2K^1)	R =	·023
	κ =	1°·08		ζ =	182°·01		ζ =	341°·81		ζ =	180°·51
M_4	R =	·009		H =	·132		H =	·081		H =	·022
	ζ =	257°·26		κ =	323°·07		κ =	291°·01		κ =	8°·69
	H =	·010	J_1	R =	·031	R_2	R =	...	$(2M^2K^1)_3$	R =	·005
	κ =	206°·46		ζ =	169°·93		ζ =	...		ζ =	122° 01
				H =	·027		H =	...		H =	·005
				κ =	330°·09		κ =	...		κ =	217°·65

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·025	114°·70	·028	63°·49
„ Fortnightly „	·063	101·72	·047	9·85
Luni-Solar „	·017	343·61	·017	9·01
Solar-Annual „	·263	216·34	·263	165·28
„ Semi-Annual „	·094	250·96	·094	148·85

The Tide Tables.

In addition to the calculations already mentioned, the usual work has been done in connection with the issue of the Tide Tables for 1893 (which arrived at my office from London in two instalments, namely, on December 23rd, 1892, and January 24th, 1893, and were at once distributed) and with the preparation of those for 1894. The dates of arrival of the Tide Tables for 1893 were too late to admit of their reaching their numerous purchasers in time for their requirements. In this connection the Vice-Chairman, Port Commissioners, Rangoon, sent me copies of two letters addressed to him by the Manager, Irrawaddy Flotilla Company, Limited, dated the 24th and 31st January 1893, respectively. In these letters it was set forth that "the business of the Company in tidal waters threatened to be very much disorganised owing to the delay in the arrival of the Tide Tables": the Manager stated moreover that he found himself unable to prepare time-tables of sailings for the month of February, which was certain to cause pecuniary loss to his Company, and affect its reputation for regularity; that he was also unable to make engagements for the docking of vessels, thus prejudicing the Company in the estimation of ship-owners; and he concluded by expressing the hope that in future the Tide Tables would be delivered by the 1st January. During January and February, while on my tour of inspection, I received several complaints of the inconvenience occasioned by the delay. I was at Rangoon on the 31st January, at Moulmein on the 1st February and at Mergui on the 9th February, and on those dates the Tide Tables for 1893 had not arrived at the ports named. The Surveyor-General and the Deputy Surveyor-General have expressed their opinion that a change in the manner of issue of the Tide Tables is desirable. I have previously mentioned that, during my privilege leave in England, I went to the India Office and proposed that the forwarding of the Tide Tables for 1894 to my office, immediately after they had been printed and bound, should be done by Mr. Roberts so as to avoid delay. It is also desirable that as soon as the arrangement can be carried out, he should undertake the distribution of the purchase copies of the Tide Tables and send them direct to the purchasers instead of to my office, in the manner proposed in my letter to the Deputy Surveyor-General, No. 18, dated 4th January 1893, and approved by him. In connection with the Tide Tables for 1894, the values of the constants, which were calculated in the usual manner, were sent to Mr. Roberts ready for use in the Tide Predictor; and in addition he was furnished with the actual values during 1892 of every high and low water at twelve stations, measured in duplicate from the tidal diagrams, together with tidal observations for the same year taken daily during daylight from graduated staves at the sites of the Cocanada, Chittagong and Moulmein tidal observatories, and similar observations for some months of that year taken at the sites of the Cochin and Akyab observatories, kindly supplied with great regularity by the Port Officers. In order to save Mr. Roberts the labour of the calculation, all the predicted times and heights of high and low water for 1892 at these stations were compared with the above-mentioned actual values and the errors tabulated, thus giving him in a convenient form information likely to assist him in improving the predictions. In my last year's report, I drew attention to the principal discrepancies between the actual and predicted values of the tides at the three principal riverain stations for the year 1891, the Tide Tables for 1891 being at that time the latest volume that could be examined, and I discussed an error that had been gradually accumulating for several years during the month of August at Moulmein. I have already remarked on the unsatisfactory circumstance that this year (1893) the excess height of predicted low waters in August at Moulmein is above the average, and that a similar error has been noticed throughout the greater part of July.

On examining the comparisons at Kidderpore, Rangoon and Moulmein for 1892, it is noticeable that the height predictions at Kidderpore were too high at both high and low water during the last half of October, just as they had been in the preceding year. At Rangoon they were too high at low water in June, July, August, September, October, the last half of November, and the whole of December; in the preceding year there had

been similar errors, but they extended only from August to November. At Moulmein they were too high at low water in June, July and August, a recurrence in part of the errors remarked for 1891. These errors deserve notice because it may be not only inconvenient but dangerous for the anticipated height of the tide to be too great especially at low water. As regards the time predictions, it may be noticed that during seven months at Rangoon the predictions of low waters were distinctly too late, to the average extent of about a quarter of an hour. During three months the high water predictions were similarly in error. The excessive errors of the height predictions may be partly due to the fact that the monsoon conditions during 1892 were exceptional and tended to diminish the heights of the low waters at riverain ports in Burma during August.

The datum for the Tide Tables for 1894 is the datum of soundings in the latest charts. A table giving the particulars of the datum at each tidal station was furnished in my last annual report and is printed at page lii of the appendix to the General Report for 1891-92.

The volume of Tide Tables for 1894 will contain predictions for 33 tidal stations. The amount realised by the sale of the Tide Tables is much the same as it was last year, and the limited number of presentation copies are distributed in strict accordance with the lists sanctioned by Government.

The usual tabular statements are appended, showing the percentage and amount of the errors in the predicted times and heights of high and low water for the year 1892 at 15 stations, as determined by comparison of the predictions entered in the Tide Tables for that year with the values obtained by actual measurement.

No. 1.

Statement showing the percentage and the amount of the Errors in the Predicted Times of High Water at the various Tidal Stations for the year 1892.

Stations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	678	37	43	10	7	3
Kurrachee	705	20	36	20	17	7
Bhávnagar	707	28	37	11	14	10
Bombay { Apollo Bandar	708	33	47	9	8	3
Bombay { Prince's Dock	706	36	43	10	7	4
Cochin	459	15	59	12	12	2
Tuticorin	687	41	42	8	6	3
Cocanada	366	85	15	...	...	...
Kidderpore	706	24	36	14	15	11
Chittagong	366	36	28	12	14	10
Akyab	475	33	43	8	11	5
Rangoon	707	25	36	14	17	8
Moulmein	360	37	42	11	6	4
Mergui	685	43	40	6	7	4
Port Blair	649	28	46	14	10	2

No. 2.

Statement showing the percentage and the amount of the errors in the Predicted Times of Low Water at the various Tidal Stations for the year 1892.

Stations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	663	37	46	7	7	3
Kurrachee	698	25	39	15	16	5
Bhávnagar	673	22	39	13	14	12
Bombay { Apollo Bandar	704	31	43	11	10	5
Bombay { Prince's Dock	705	34	46	11	7	2
Cochin	460	23	59	9	8	1
Tuticorin	679	38	47	8	5	2
Cocanada	366	79	19	2	...	...
Kidderpore	704	21	38	13	17	11
Chittagong	365	34	26	10	17	13
Akyab	480	26	32	8	12	22
Rangoon	707	26	35	10	14	15
Moulmein	359	31	46	8	12	3
Mergui	696	25	41	12	16	6
Port Blair	645	30	49	12	8	1

No. 3.

Statement showing the percentage and the amount of the errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1892.

Stations.	Number of comparisons between the actual and predicted values.	Mean Range at Springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per cent.	Per cent.	Per cent.	Per cent.
Aden	678	6·7	90	10	...	...
Kurrachee	705	9·3	69	26	5	...
Bhávnagar	707	31·4	34	23	19	24
Bombay { Apollo Bandar	708	13·9	72	23	5	...
Bombay { Prince's Dock	706	13·9	65	26	8	1
Cochin	459	3·2	89	11	...	...
Tuticorin	687	3·2	85	15	...	...
Cocanada	366	5·0	76	19	3	2
Kidderpore	706	11·7	35	25	20	20
Chittagong	366	13·3	29	28	18	25
Akyab	475	8·3	71	26	2	1
Rangoon	707	16·4	54	30	11	5
Moulmein	360	12·7	39	25	15	21
Mergui	685	18·1	61	28	9	2
Port Blair	649	6·6	87	13	...	...

No. 4.

Statement showing the percentage and the amount of the errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1892.

Stations.	Number of comparisons between the actual and predicted values.	Mean Range at Springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
			Per cent.	Per cent.	Per cent.	Per cent.
Aden	663	6·7	91	8	1	...
Kurrachee	698	9·3	82	17	1	...
Bhávnagar	673	31·4	12	13	15	60
Bombay { Apollo Bandar	704	13·9	69	26	5	...
Bombay { Prince's Dock	705	13·9	67	25	7	1
Cochin	460	3·2	85	15	...	...
Tuticorin	679	3·2	83	16	1	...
Cocanada	366	5·0	70	21	4	5
Kidderpore	704	11·7	45	30	16	9
Chittagong	365	13·3	50	25	12	13
Akyab	480	8·3	68	25	6	1
Rangoon	707	16·4	26	29	20	25
Moulmein	359	12·7	26	21	20	33
Mergui	696	18·1	42	29	20	9
Port Blair	645	6·6	87	13	...	...

No. 5.

Table of Average Errors in the Predicted Times and Heights of High and Low Water at the several Tidal Stations for the year 1892.

Stations.	Mean range at springs in feet.	Average Errors					
		Of time in minutes.		Of height in terms of the range.		Of height in inches.	
Open Coast.		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
Aden	6·7	10	9	·025	·025	2	2
Kurrachee	9·3	15	13	·036	·027	4	3
Bhavnagar	31·4	14	15	·021	·040	8	15
Bombay { Apollo Bandar	13·9	10	11	·018	.024	3	4
Bombay { Prince's Dock	13·9	10	10	·024	·024	4	4
Cochin	3·2	12	11	·052	·078	2	3
Tuticorin	3·2	9	9	·078	·052	3	2
Cocanada	5·0	3	3	·050	·067	3	4
Akyab	8·3	11	18	·030	·040	3	4
Mergui	18·1	9	13	·018	·028	4	6
Port Blair	6·6	11	10	·025	·025	2	2
General Mean		10	11	·034	·039		
Riverain.							
Kidderpore	11·7	15	16	·057	·043	8	6
Chittagong	13·3	13	15	·050	.038	8	6
Rangoon	16·4	14	15	·025	.046	5	9
Moulmein	12·7	10	11	·052	.072	8	11
General Mean		13	14	·046	·050		

The foregoing statements for the year 1892 may be summarised as follows :—

Percentage of Time predictions within 15 minutes of actuals.

	High water per cent.	Low water per cent.
11 Open coast stations	77	76
4 Riverain stations	66	64

Percentage of height predictions within 8 inches of actuals.

	High water per cent.	Low water per cent.
11 Open coast stations	93	88
4 Riverain stations	66	63

Percentage of height predictions agreeing with actuals within one-tenth of mean range at springs.

	High water per cent.	Low water per cent.
11 Open coast stations	96	95
4 Riverain stations	91	91

These figures are very satisfactory, and show a high standard of accuracy in the predictions taken as a whole.

Bench-Marks.

During the year under report 1 standard bench-mark (Rangoon), 53 ordinary embedded bench-marks, 378 inscribed or minor bench-marks, 54 railway bench-marks 3 P. W. D. bench-marks, 3 Revenue Survey bench-marks, and 6 G. T. Survey stations were connected in the course of last season's levelling operations by the levelling detachment; and 1 G. T. S. bench-mark of the spirit-levelling operations in connection with Mergui Base Line was connected by double levelling in the course of the tidal observatory inspection operations.

The last-mentioned bench-mark is B. M. 1 of "spirit-levelling operations in connection with Mergui Base Line." It was originally a secondary trigonometrical station of the Eastern Frontier Series which I built in December 1880, when I was in charge of that series, and at which trigonometrical observations were taken from an elevated staging. The station, or bench-mark, was built half a foot above ground level, so as to

be accessible to surveyors engaged in traversing and spirit-levelling, and it was placed at the south-east corner of the Court-house, so as to be under the daily observation of the Deputy Commissioner. I found it most carefully preserved, and through it the tidal observatory is now connected by spirit levelling with the Mergui Base Line of verification. The trigonometrically determined height of this bench-mark derived from the Calcutta Base Line through 1,200 miles of the triangulation of the Eastern Frontier Series was 123 feet above mean sea level. Its height, now accurately ascertained by spirit-levelling, is, neglecting fractions of a foot, 114 feet above mean sea level at Mergui.

All the bench-marks of reference at the tidal stations were found undisturbed and in good order without exception.

In addition to those mentioned above, bench-marks were laid down as follows :— At the new station of Muscat one embedded and two inscribed bench-marks of reference were laid down and connected by spirit-levelling with the bed-plate of the tide-gauge. At the new station of Bushire two embedded and two inscribed bench-marks of reference were laid down and connected by spirit-levelling with the bed-plate of the tide-gauge.

At Gulbarga station of the Great Indian Peninsular Railway, the demolition is reported of embedded bench-mark No. 136 in Series I of Spirit-Levelled Heights No. 3. Bombay Presidency, season 1879-80, a pamphlet now obsolete and superseded by Nos. 2 and 3 Bombay Presidency and Nizam's Dominions, season 1877-80, in which the same bench-mark appears as No. 211 in Section II, and as No. 1 in Section III. The removal of the bench-mark was necessitated by the extension of a waiting room.

The description of the embedded bench-mark No. 60 in Section II of Spirit-Levelled Heights Nos. 2 and 3 Bombay Presidency and Nizam's Dominions, season 1877—80, has been altered owing to the re-construction of the gate-keeper's quarters mentioned in the description. The corrected description is as follows :—" G.T.S., B.M. at Poplaj. This bench-mark is embedded about 6 inches below ground level within the railway enclosure, and close to the gate-keeper's quarters at Poplaj level crossing of the Great Indian Peninsula Railway. It is 35 links south of the nearest rail, and 3 links from the north-west corner of the gate lodge, on which the letters B. M. have been cut."

At Madras the standard bench-mark adopted by Government of Madras Resolution No. 737 in the Public Works Department, dated 24th March 1885, will shortly be destroyed on the demolition of the light-house. Bench-mark No. 5, section Madras to Arkonam, Spirit-Levelled Heights No. 1. Madras Presidency, season 1869-85, cut on the Madras memorial stone laid by His Royal Highness the Prince of Wales has been suggested by me as a suitable standard bench-mark for Madras, and the Engineer to the Harbour Trust Board has expressed his willingness to place the necessary inscriptions on the stone. This bench-mark has been adopted as the bench-mark of reference for the tidal observatory in the place of the present standard bench-mark.

At Calcutta, the Assistant Surveyor-General has been requested to have prepared and erected a polished stone block 3 ft. by 3 ft. by 3 ft. 6 inches, to be embedded 6 inches in a plinth, so that the exposed part of the block will be a 3-foot cube, on the spot selected during my visit to Calcutta in January, namely, the small grass plot immediately in front of the Mathematical Instrument Office. This will be the standard bench-mark for Calcutta.

At Rangoon, I have arranged with Mr. Darlington, the Vice-Chairman of the Port Commissioners, for the supply by Messrs. Bulloch Brothers of inscribed gun-metal plates for insertion into the sunken spaces reserved for them on the standard bench-mark for Rangoon. The standard bench-mark stone was sent from Bombay by me in September 1887 and, shortly afterwards, erected by Mr. Reichenbach. It was for the first time connected by spirit levelling with the tidal observatory (then at Latter Street Wharf) in March 1888, and since then its level has been tested from time to time, the final levelling having been executed last season. The bench-mark has undergone no change of level, and as the necessary data are also now complete, the inscriptions will be furnished from my office to Mr. Darlington and Messrs. Bulloch Brothers at an early date.

Levelling Operations.

In July 1892 it was decided, owing to the urgent need of a line of first class spirit-levelling from Elephant Point to Rangoon and thence to Mandalay, to employ my Levelling Detachment in Burma during the field season of 1892-93, to carry out the necessary work. The operations consisted of a continuous line of double levelling joining together Elephant Point open coast tidal station (closed), Elephant Point riverain tidal station (closed), Rangoon tidal station (comprising the tidal observatory now in operation at Booking Street Wharf, and the closed observatory at Latter Street Wharf) and Mandalay. The line of double levelling was divided into the two following sections :—

(*a*) Rangoon to Elephant Point.
(*b*) Rangoon to Mandalay.

The levelling was carried over ground, the total rises and falls of which amounted to 6,893 feet, and the out-turn consists of 464½ miles of double levelling, in the course of which the instruments were set up at 3,711 stations and the heights of 1 standard bench-mark, 53 permanent embedded bench-marks, 378 permanent inscribed or minor bench-marks, 54 railway bench-marks, 3 Public Works Department bench-marks, 3 Revenue Survey bench-marks, and 6 Great Trigonometrical Survey stations were connected. This

is an excellent out-turn and very creditable to Mr. Bond, who conducted the operations, especially as it was attained under most unfavourable climatic conditions, the particulars regarding which will be found in the appended extract from his report to me on his season's work, given below. I also wish to express my obligations to Mr. G. F. Mathew, C.I.E., the Manager of the Burma State Railway, for the assistance he gave Mr. Bond, without which, Mr. Bond reports, he would have experienced much inconvenience, trouble and delay.

Extract from Report by MR. J. BOND, *Extra Assistant Superintendent, 5th Grade, on the levelling operations executed.—Season 1892-93.*

There being a pressing demand for spirit-levelling in Burma, owing to the discrepancies found to exist between the Trigonometrical, Topographical, Revenue and Railway heights, the following programme was sanctioned and completed during the season under report, *viz.*, to carry a line of double levelling from Elephant Point tidal station, connecting Rangoon tidal station, and following the railway line, *viâ* Toungoo and Pyinmana to Mandalay, to furnish values of height for the Engineers to base their work on for irrigation and other purposes, and to connect the heights of the Great Trigonometrical Survey stations of the Mandalay series and the Revenue Survey, railway and such such other bench-marks as were conveniently near the main line of levels.

The operations during the season comprise the following lines of double levelling :—

I.—From Rangoon to Elephant Point connecting the three following tidal stations :—

(1) Rangoon station, comprising the present tidal observatory at Booking Street Wharf and the closed observatory at Latter Street Wharf.
(2) Elephant Point Riverain station at Pilakat Creek.
(3) Elephant Point open coast station.

The levelling was carried along the strand and railway line to the confluence of the Hlaing and Panhlaing rivers and thence across the Rangoon river, *viâ* Dala, Danok and Mokkyun to Elephant Point, all in the Hanthawaddy district.

II.—From Rangoon along the Sittang and Mandalay lines of the Burma State Railway *viâ* Pegu, Toungoo, Pyinmana, Yamèthin and Kyauksè to Mandalay, connecting the following Great Trigonometrical Survey stations of the Mandalay series :—

Myayabengkyo H. S.
Toungoo S.
Pyinmana S.
Yamèthin S.
Taungpila H. S.
Mandalay H. S.

In addition a short branch line of 2¾ miles was specially undertaken for the Public Works Department from Mandalay Railway Station to the Irrawaddy shore, where two embedded bench-marks were connected, one at the south-east corner of the Military Police Supply Depôt and the other in the verandah of the Marine Transport Office.

On the completion of this section, Rangoon to Mandalay, the party returned by rail to Rangoon and thence by boat to Dala, where the work had been temporarily closed at the beginning of the season, to resume operations on the section to Elephant Point. The rainy season of 1893 set in exceptionally early and the work was considerably hampered on this section by incessant rain, which flooded the country and swamped the camp, sowing the seeds of disease in most of the establishment and completely disabling two recorders and one-fifth of the men, of whom one died in Rangoon and another in Poona during the recess. Particular care was taken during the operations to ensure the stability of the stands of the instruments in the water and soft mud, and frequently the instruments had to be removed two or three times before suitable ground could be obtained, care being taken invariably to maintain the equidistance of the staves from the instrument, the feet of which were forced well home. A comparison of the results of the two instruments on this work shows a difference of ·010 feet, a closer agreement than is usually obtained for the same distance on firm soil; this can only be attributed to the special care taken and to the apparent absence, when working over water, of that unsteady appearance of the levelling staves which generally gives trouble, as the day advances, when working over land resulting from the unequal density of the different layers of the air expanded by contact with the heated soil. We commenced work at Dala on the 29th April and continued on steadily through mud and slush varying in depth from 6 inches to a couple of feet, and in pouring rain, crossing numerous creeks, at considerable risk, over bridges peculiar to Burma, consisting of the stem of a single tree or a bamboo structure varying in width from one to three bamboos, which in crossing sway up and down in a most uncomfortable manner, and had the satisfaction of completing the season's programme in its entirety on connecting the bench-mark at Elephant Point obelisk on the 13th May.

The course followed in the levelling, from Rangoon to Elephant Point, was selected with the object of picking up as many Revenue Survey bench-marks as possible, but unfortunately these bench-marks, the only ones the country afforded, were of a temporary nature. Some are described as being "on the root of a tree," where the locality is now a mass of roots, others on "stout wooden pegs" which must have decayed or have been cut down or swept away by the floods, they having been laid down and connected twelve years previously. Of those cut on masonary pillars and pagodas, no sign of the letters B. M. or of the distinguishing mark ⊕ could be found, except in two cases; the others had apparently disappeared with the surface of the masonry which had crumbled away, obliterating any bench-mark that may have existed on the surface. Besides this, the descriptions of the Revenue Survey bench-marks, furnished to me, were very meagre, and in the case of the one on the step of the obelisk, inaccurate. The bench-mark on the Elephant Point obelisk is described as being on the fifth step from the top, on the North-East side, but as there are only four steps, I inferred that the ground had silted up over the fifth step; and set to work to have it removed. I exposed the basement and made a very careful search for the mark but without effect. All the steps were then washed and carefully scrutinized, but no mark was discovered. I was about to leave the place disappointed, when the thought struck me to chop and peel away the cement on the steps of the obelisk, laying bare the brick-work; and eventually I found on the fourth step from the top the usual Revenue Survey distinguishing mark (⊕) cut on brick and the grooves filled in with red lead: there were other grooves and lines on either side of the mark also filled in with red lead, which were probably intended for the letters R. S. I connected this point with the levelling and, during the recess in looking through the levelling file, I found that the description of the point I had connected agreed with that furnished by Captain Sandeman to Captain Baird in his letter No. 50, dated 17th March 1881, showing its connection by the Revenue Survey with the bench-marks of reference of the tidal observatory at Elephant Point open coast station. The importance of connecting the work with the Revenue Survey bench-marks was fully recognised; and at great discomfort, owing to the rains

much valuable time was lost in the careful search made for the bench-marks contained in the list, with which I had been supplied, and those noted on the Revenue Survey map.

The following are the Revenue Survey bench-marks connected:—

	Height above mean water level at Rangoon in feet.		Error of Revenue Survey value in feet.
	Rev. Survey value.	G. T. S. value.	
B. M. No. 165	9·945	11·222	—1·277
Elephant point obelisk	12·547	13·785	—1·238
B. ⊕ M. at Kemmendine on the West side of lower Kemmendine road	...	21·817	

I beg to acknowledge the great courtesy shown to me by Mr. G. F. Mathew, C.I.E., the Manager of the Burma State Railway, and the ready help he gave in sanctioning all the concessions I asked for to facilitate my work along the line, without which I should have been put to much inconvenience, trouble and delay.

Results of comparison of staves—Season 1892-93.

Date of comparisons.	Mean difference of length of pairs of staves from 10 feet.	
	Staves B1 & B2.	Staves B3 & B4.
Rangoon, 31st October 1892	+0·001184	+0·002173
Toungoo, 29th January 1893	—0·000538	—0·400022
Mandalay, 16th April 1893	—0·002389	—0·003520
Dala, 15th May 1893	—0·000566	+0·000444

I append the usual tabular statement of the out-turn of levelling, also the following tables:—

Table A, giving the heights by spirit-levelling and triangulation of the Great Trigonometrical Survey principal and secondary stations connected.

Table B, giving the heights by Survey of India spirit-levelling and Railway levelling of nine railway bench-marks selected from those connected on the Burma State Railway. The railway values of heights given in this table were supplied by the Manager and Engineer-in-Chief, Burma State Railway, in letter No. 6093-98W.R., dated 31st July 1890, to Mr. G. B. Scott, in charge No. 3 Party, Survey of India, who kindly furnished Mr. Bond with a copy. Mr. Bond has reported to me that he applied to the Manager and to the Engineer-in-Chief for the values of all the railway bench-marks along the railway line, and was informed by the latter that the records had been destroyed by fire.

Table C, showing the fall per mile of mean water level of the Rangoon River from Rangoon to Pilakat Creek and thence to the sea.

Tabular Statement of out-turn of work for the field season 1892-93, Section Rangoon to Mandalay.

During the month of	Number of miles, Double Levelling.		Total Number of feet.		Number of stations at which the instrument was set up.	Number of bench-marks embedded, inscribed and connected.							
	Main Line.	Branch Line.	Rises	Falls.		Embedded.	Test Bench-marks embedded.	Inscribed.	G. T. Survey stations.	Railway.	Public Works Department.	Revenue Survey.	G. T. Survey Standard.
	M. C. L.	M. C. L.											
November 1892	27 11 24	0 31 32	120·8	91·4	192	4	...	28	...	1	...	...	...
December 1892	66 55 26	0 50 16	213·7	230·3	479	7	...	56	...	8	...	...	...
January 1893	76 67 72	12 0 39	431·8	1768·2	848	9	...	70	2	9	...	...	...
February 1893	96 71 26	2 5 58	632·7	635·8	739	11	...	89	1	14	...	...	...
March 1893	87 54 14	15 46 20	637·1	941·6	794	11	...	82	2	14	...	...	...
April 1893	31 60 50	8 62 68	239·0	709·7	380	7	...	38	1	8	1	...	...
Total	387 0 12	39 36 33	2275·1	4377·0	3,432	49	...	363	6	54	1	...	...

Section Rangoon to Elephant Point.

November 1892 .	10	69	24	0	11	20	52·6	64·0	103	...	...	11	...	...	...	1	1
April 1893 .	2	43	62	0	0	0	4·4	7·9	19	...	...	...	...	...	...	...	...
May 1893 . .	24	0	46	0	33	10	54·1	58·2	157	4	...	4	...	...	2	2	...
TOTAL .	37	33	32	0	40	30	111·1	130·1	279	4	...	15	...	...	2	3	1
GRAND TOTAL .	424	33	44	39	79	63	2386·2	4507·1	3,711	53	...	378	6	54	3	3	1

	M.	Ch.		
TOTAL NUMBER OF MILES DOUBLE LEVELLING	464	33	Total of Rises & Falls.	6893·3.

Table A.

List of Great Trigonometrical Survey Principal and Secondary Stations connected by Spirit-Levelling, Season 1892-93.

SERIES.	Name of Station.	Height in feet above Rangoon mean water level by Spirit-Levelling.	Height in feet above mean sea level by Triangulation.	REMARKS.
		*		
Eastern Series. Frontier	Myayabengkyo H. S. .	1,407	1,411	Upper exposed mark-stone.
	Toungoo S. . . .	176·1	185·7	Top of triangular pillar a foot of protecting pillar.
Mandalay Series .	Pyinmana S. . . .	419	429	Upper exposed mark-stone.
	Yamèthin S. . . .	697	705	Arrow head on top surface of Pagoda.
	Taungpila H. S. . .	1,005·2	1,010·1	Top of circular pillar at foot of protecting pillar.
	Mandalay h. s. . .	774·4	782·7	Top surface of base of Pagoda at foot of protecting pillar.

* To refer these spirit-levelled heights to mean water level at Pilakat Creek (Elephant Point Riverain Tidal Observatory—*new site* a correction of +0·55 feet should be applied, and they require a correction of +0·91 feet to refer them to mean sea level, determined from one year's observations (May 1880 to May 1881) taken at Elephant Point Open Coast Tidal Observatory—*old site*.

Table B.

List of Railway Bench-marks on the Burma State Railway selected from those connected by the Survey of India Levelling Operations, Season 1892-93.

No.	BENCH-MARKS.	Height in feet above Rangoon mean water level by Survey of India Levelling Operations.	Height in feet above mean sea level by Railway Levels.
		*	
390	Rail at Thabyedaung	332·58	322·63
401	„ Myittha	303·17	293·63
408	„ Minzu	290·06	280·63
414	„ Kyaukse	280·00	270·63
421	„ Bilin	266·09	256·63
427	„ Singaing	250·17	240·63
439	„ Myitngé	248·73	238·63
444	„ Myohaung	246·67	235·82
450	„ Mandalay	247·48	236·82

* To refer these Survey of India heights to Mean Water Level at Pilakat Creek (Elephant Point Riverain Tidal Observatory—*new site* a correction of +0·55 feet should be applied, and they require a correction of +0·91 feet to refer them to mean sea level, determined from one year's observation (May 1880 to May 1881) taken at Elephant Point Open Coast Tidal Observatory—*old site*.

Table C.

Showing the fall per mile of Mean Water Level of the Rangoon River from Rangoon to Pilakat Creek and thence to the sea.

DATUM { Graham Smyth's datum (23 27 feet below his bench-mark) which corresponds to the zero of tide-gauge at Brooking Street Wharf and to the River Surveyor's and the Marine Survey of India datum for Rangoon.

Names of Tidal Observatories.	Distance apart in miles.	Height of Mean Water Level above datum.	Average inclination per mile.
		Feet.	Fall in inches.
Rangoon Brooking Street Wharf	...	10·279	...
Pilakat Creek (Elephant Point Riverain Observatory) . . .	21	9·731	0·31
Elephant Point Open Coast Observatory	3	9·372	1·44

BURMA.

Extract from the Narrative Report of MR. G. B. SCOTT, *in charge of No. 3 Party, giving description of the country surveyed in season 1892-93.*

SHWEBO DISTRICT.

The Shwebo district covers an area of about 3,000 square miles, lying roughly between Lat. 22°20′ and 23°30′ and Long. 95°30′ and 96.° A low range of hills runs through it along the right bank of the Irrawaddy which forms the eastern boundary of the district, and therefrom the country slopes westward to the Mu river which forms the western boundary. The latter river rising in the hills of Wuntho, falls into the Irrawaddy about 20 miles below Sagaing and Ava.

Of the entire area, about one-third is a belt of low hills, ravines and forest, narrowed to from 2 to 4 miles on the south and increasing gradually in breadth northwards where it stretches across the entire district. The rest of the district westward is level, or gently undulating.

Among the hilly portions, small hamlets are scattered at intervals, round which lie a few hundred acres of cultivated land; the remainder of the district, either is or has been almost entirely under cultivation, at one time or another. The greater portions of the latter tracts have been surveyed cadastrally, and of the 1,500 square miles surveyed, about 40 per cent. is under crop or lately thrown out of cultivation. Of the cultivated portion some small patches on the banks of the Irrawaddy where the hills recede, others lying along the banks of the Mu river, and a block of about 70 square miles in the neighbourhood of Shwebo town, are irrigated rice lands. The rest of the country produces only dry weather crops, such as maize, millets and vegetables. The large block is irrigated by the Mu canal, which was excavated by the founder of the Aloungpra dynasty, but is now in a sadly neglected condition; extensive irrigation projects are now being undertaken, which, when completed, should supply water at certain seasons for fully 1,000 square miles of country. The greater portion of this tract is at present greatly in need of water, for the rainfall, even during the present season, which has been an exceptionally wet one in other parts of Burma, has been very deficient in Shwebo. So much has the district felt this want, that hundreds of families have deserted their homes and gone south to search for employment in Lower Burma. The lands so deserted are soon covered with thorny scrub and cactus jungle, or with long grass, under which it is very difficult to search out the limits of former fields, of which the survey is still very necessary in case the tenants should return when water is more abundant. The villages and hamlets, of which there are some 300, are small and built entirely of mat and thatch, and are usually bare of trees.

The *Phoongyi Kyoungs* which are numerous, are, on the contrary, usually buried among groves of mangoes, guavas, palms and other fruits, watered from well-built masonry wells; and there appears to be no reason, beyond the carelessness and lazy habits of the people, why every village should not also be similarly favoured.

In the absence of wells and canals, as I have said, the greater portion of the country suffers from want of water, and numerous families are employed in collecting salt from small brine pits which occur at intervals from north to south, along the line of railway which runs through the district. Numerous water-courses cross the district from the hills to the Mu river, but, except after rain, all are dry. When in flood, they cut across the railway line and the Mu canal, rendering extensive repairs necessary on the former, and the latter almost useless, unless constantly repaired. A strange peculiarity of several of these water-courses is the existence of mud springs in constant action; mounds of

earth, rising to 5 or 6 feet, indicate the locality of these springs, and round each is a space of dangerous quicksand or quagmire where cattle and ponies are often lost.

Near the village of Halingyi, about 12 miles south-east of Shwebo, are numerous springs of water, some cold, others hot; the temperature of the latter sometimes rising to boiling point, at others falling to 96° Fahrenheit or thereabouts.

The inhabitants are all Burmans, Buddhists by religion, except of two or three villages near the Mu river who are Roman Catholics, similar to those in Sagaing, mentioned in last year's report, descendants of the Portuguese brought by Aloungpra from Syriam.

The only place worth calling a town is Shwebo itself, formerly Matso-bo-myo, the town of the hunter chief, now Shwe-bo-myo, the town of the golden chief, which is interesting as being the first capital of Aloungpra, or Aloungphya, before he commenced the career of conquest that made him founder of the last dynasty of the kings of Burma.

The population of the town is about 7,000, apart from the British and Native regiments and others which form the garrison; the total population of the district is about 135,000, of which the number of females exceeds the number of males by about 5,000 according to the late census. The cause of this disproportion is probably due to the fact that more men than women have gone south searching for employment.

The hilly portions of the country abound in deer, wild fowl and partridge in the way of game, while leopards are very numerous, and occasionally wild elephants and an occasional tiger are seen in the wildest recesses. Jackals, which some hold are not to be found in Upper Burma, may be seen any evening trotting across the racecourse, near the Shwebo Cantonment, and may be heard elsewhere, the cry, however, wanting the dismal preliminary howl of their Indian brethren. The remains of an old fort and moat surround the Shwebo town, but there is little else of interest in the district, except the coal-fields of Kabwet and Letkabin. The proximity of these to the Irrawaddy will render them very valuable, if hereafter coal of good quality and in sufficient quantities is discovered.

Iron was formerly worked in the Pintha township in the north of the district, and here and there oil has been observed, but neither are worked at present.

Extract from the Narrative Report of COLONEL R. G. WOODTHORPE, C.B., R.E., *in charge No. 11 Party, on the operations with the* ANGLO-SIAM BOUNDARY COMMISSION, *Season 1892-93.*

The party left Bangalore on the 27th and 28th October 1892 and arrived in Rangoon on the 4th November. A few days were spent in making the necessary arrangements with the Commissariat for supplies, blankets, etc., for the Boundary party, as I had been informed that it would be necessary to carry at least three and a half months' rations on starting from Fort Stedman. I then proceeded to Mandalay with Messrs. Doran and Kelly.

The party assembled on the 16th November at Meiktila road, where the bulk of *khalásis* and the coolies had been halted. Here, to my disappointment, I found that the carts, which I had requested the Deputy Commissioner to have ready for me to start for Fort Stedman, had not arrived, and two days were wasted in a vain attempt to come to terms with the cart-owners; and in this we were not assisted but rather obstructed by the native officials. In the meantime, Mr. Hildebrand was getting anxious to see me to settle many matters which could only be done in personal communication; so on the 18th November I sent a telegram to the Chief Commissioner, reporting the obstruction I was experiencing and the grievous delay caused thereby, and packing a few things on six coolies and my pony, I made double marches to Fort Stedman, arriving there on the 23rd November. I was pleased to receive a telegram from Mr. Doran, saying that carts had been collected and he hoped to reach Fort Stedman on the 29th.

The Commission was to have started on the 25th November, but in consequence of all these delays, Mr. Hildebrand had obtained permission to postpone his departure till the 5th December, by which time all necessary arrangements were completed. Mr. Hildebrand and I were to proceed *viâ* Taunggyi, picking up the rest of the camp on the evening of the second day. Mr. Kitchen had arrived in a low state of health and the Civil Surgeon feared he would not be able to take the field till about the 15th December. At 7 A.M. on the 5th December I had started off my men and was following with Mr. Hildebrand. Passing the house of the Civil Surgeon, Dr. Evers, who had kindly taken charge of Mr. Kitchen, I went in to say "Good-bye" to the latter and was grieved to find that he had expired early that morning. It was too late then to delay my own departure, but Messrs. Doran, Kelly, and Shaw remained to perform the obsequies of their departed friend, who was buried that evening in the little cemetery perched on a knoll, overlooking the great Inle lake.

Mr. Hildebrand's camp marched to Möng Hang *viâ* Möng Nai and Möng Pan. At Möng Nai our party was joined by Mr. H. G. A. Leveson, I.C.S., Assistant Superintendent, Southern Shan States, who was to have charge of the Boundary party working west, and Captain H. R. Davies, Oxfordshire Light Infantry, who was to accompany Mr. Hildebrand as Intelligence Officer. Captain H. B. Walker, Duke of Connaught's Light Infantry, had already joined us as Intelligence Officer with Mr. Leveson's party. We reached

Möng Hang on the 1st January 1893. The Commission then assembled consisted of the following :—

A. H. Hildebrand, Esq., C.I.E.	Commissioner.
H. G. A. Leveson, Esq.	Assistant Commissioner.
Subadar Hossein Beg Do. Srinivasulu.	In command of escort.
Arunachalam Naicker T. M. Ramiah Naidu	Hospital Assistant Do. do.
Col. R. G. Woodthorpe, C.B., R.E.	In charge of the Survey.
P. Doran, Esq.	Extra Assistant Superintendent, Survey of India.
W. M. Kelly, Esq.	Sub-Assistant ditto ditto.
H. G. Shaw, Esq.	Ditto ditto ditto.
Mahmud Hossein	Surveyor.
Ramsabad Abdul Rahim Kudratullah	Sub-Surveyors.
Capt. H. R. Davies, Oxfordshire Light Infantry Capt. H. B. Walker, Duke of Connaught's Light Infantry	Intelligence Officers.
Lance Naik Data Ram Sepoy Madho Pershad Invedi, 10th Bengal Infantry	Surveyors to Intelligence Officers.

Mr. C. E. W. Stringer, British Vice-Consul, Cheingmai, met the Commission at Möng Hang on the 1st January, 1893, and accompanied it as far as Hongluk, from whence he returned on the 15th February.

The escort consisted of 100 rifles of the 22nd Madras Infantry, including twelve mounted men. The transport consisted of five elephants, transport ponies, Panthe mules, and a few Khasia coolies.

The Siamese Commission joined us on the 4th. It was composed as follows :—

Laung Kamachat Phairint Laung Sarasiddhi Yanukar	Commissioners.
Laung Sakal Kibpramuom Laung Kamunam Kaknan Hmom Rajwongsi Kun Nay Pheo	Survey Department.

The party to work westwards left Möng Hang on the 7th January. The eastern party left on the 8th. Advantage had been taken of the halt to visit the hills Loi Kyilek and Loi Un, both peaks on the boundary, and former survey stations, from which we proposed to extend our triangulation. On the 9th we crossed the watershed into Siamese territory, reaching Möng Fang on the 10th. Here some delay occurred in making arrangements for coolies to take Mr. Kelly and Abdul Rahim to certain peaks ahead on the boundary, which I wished to have cleared; and also to accompany me to Paharpup, which I visited, cleared and observed from on the 14th January, joining Mr. Hildebrand at Taton on the 16th. Mr. Kelly left Taton with his coolies on the 17th; the coolies carried small loads and travelled badly, giving Mr. Kelly a good deal of trouble. However, he managed to do what was required, putting up an excellent bamboo mark at Loi Mohang.

I had to return from Taton to a point on the range above Meleng village. This was necessary for our triangulation and also to clear up a little obscurity in the topography of that portion of the boundary. I rejoined Mr. Hildebrand again on the 25th, and then we all moved on to Möng Ngam, where Mr. Hildebrand and I left the rest of the party to travel by the ordinary route to Me Sàn, while we took a loopline to the hills on the north, visiting another prominent point on the boundary, Loi San Sao, and a peak, Loi Pyek, both of which had been prepared as stations by Abdur Rahim with his usual energy and thoroughness. He had made friends with the hillmen, "Mu Hsüs," and had managed to get them to assist him most willingly. They are a pleasant people to deal with if properly treated, I should say, and I had a little experience of them by myself on a hill south of the Me Sàn. Mr. Hildebrand was not able to accompany me on that occasion for want of carriage, and without my Khasias I should also have been unable to leave the line of march. The point visited is a conspicuous one on the route between Möng Tun and Keng Hai (Chieng Hai), and there is a Mu Hsü village close to it, where I spent the night. After dinner, writing in the open, two or three young men and boys came and sat by me over the camp fire, and while I wrote, played their national airs on their quaint musical instruments, a species of primitive bagpipe, a gourd taking the place of the bag. I saw a similar instrument in the Lushai hills in the 1871-72 expedition. The music is weird and rather pleasing, especially when the player, himself unseen, is moving about in the forest at a little distance from the listener, when it is very suggestive of wood spirits, nymphs, and fauns.

We all reached Me Sàn on the 4th February, and there Captain Davies left us to make a detour to Ban Phuhka, while we went northwards to Loi Taw Hkam, visiting that peak with the Siamese Commissioner. On returning to the camp at Hwelai we found Mr. Kelly. Thence I visited the Mema hill and traversed that portion of the Me Huok between Hongluk and the Me Kong forming the boundary here between Burma and Siam. At Hongluk I rejoined the Commissioner. Mr. Stringer and Laung Sarasiddhi left us to return to Chiengmai and we proceeded to Kenglap. Hazy weather had then set in, and it was impossible to carry the triangulation onwards. The rest of our work was therefore performed by carrying on a careful compass and chain survey, using a subtense instrument

where the country was favourable. Frequent observations were taken for latitude, and at Möng Yawng, where we halted for a few days, we were able to measure a base and do some triangulation, fixing points which were very useful when moving onwards to Möng Kai, as the route passed over what was before a blank in the map, and we were able to fill up this gap with the plane table. At Keng Tung, we had a few fine clear days at first and again measured a base and did some triangulation with a view to fixing points ahead, as I had hoped to have been able to amplify considerably the route surveys made in previous years by the Intelligence surveyors between Keng Tung and the Salween lying through unsurveyed country, but the weather again became hazy: the haze thickened daily, while the air was full of flying embers from the jungle fires, and it was impossible to see more than a mile in any direction.

After the Siamese Commissioner left us at Hongluk, the boundary was not further demarcated, although it was ascertained carefully and marked on the map, but at Möng Kai the borders of the Keng Cheng State are so confused that no attempt has been made to define them on the map. A very intelligent man accompanied Mr. Hildebrand, Mr. Kelly and myself to the top of a commanding hill near Möng Kai, but even with his assistance it was found impossible to get any clear idea of the boundary without actually traversing it, and for this we had not the time.

The boundary demarcated by the eastern party may be described as follows in Mr. Hildebrand's words:—

> From Loi Un to Loi Pahanpup, the hill range which forms the water-parting of the Me Chai to the north, which empties itself into the Me Tun in the Mong Pan State, and of another Me Chai to the south which runs through the town of Mong Fang. From Loi Pahanpup to the Me Kok, the water-parting between the Namha on the north and the tributaries of the Me Fang on the south. It then crosses the Me Kok in a north-east direction to the water-parting of the Me Yon with the Me San and Me Hkam, so far as Loi Sam Saw, thence following it in a northerly direction to Loi Tun and thence eastward along the water-parting of the Me Hkam and Me Sai to the highest peak on that ridge, Loi Taw Hkam, and from thence north-east along the spur which terminates at the Me Sai, about one mile west of the so-called Siamese fort on that stream; thence along the course of the Me Sai to its junction with the Me Huok, and thence to the south and east along the Me Huok to its junction with the Me Kong.
>
> * * * *
>
> The clearing of all salient hill-tops on the ranges of forest, leaving one or two trees only and marking one of them with the broad arrow and 93, has been the permanent mark adopted.
>
> This mark has the advantage of being conspicuous from all the surrounding country, and as they will last for 50 years, if not destroyed, they are sufficiently permanent. The boundary itself being all conspicuous watersheds, or the course of streams, really requires no artificial marking as it has been pointed out to the Siamese Commissioner, the Keng Tung representative, and all the local inhabitants; and the Siamese Commissioner personally visited some of the more prominent peaks of the boundary with me, from which the whole line of the boundary was visible. If every mark was removed, the boundary line is still as well defined and as little open to cavil as before.

I have sufficiently indicated how the work was performed by each member of the eastern party. There was no regular work done, as no particular task could be allotted to anyone, but we had to take advantage of opportunities as they occurred. We were, moreover, travelling over country which had already been capitally reconnoitred by Mr. Kennedy, and, as a rule, we found that we could with the means and time at our disposal add but little to the existing maps. The area of new topography surveyed was done by Abdur Rahim and myself, Mr. Kelly conducting the route-traversing. I was able to detach Abdur Rahim at Kenglap and send him round by a different route to the one we took which enabled him to fill in a gap.

The work done by this party includes—

Topography	2,021	square miles.
Triangulation	3,223	ditto.
Traverses	812	linear miles.

I append Mr. Doran's report on the work done by the section under him.

The map in 3 sheets, which has been drawn to show the boundary, only contains so much topographical information, in addition to new work, as is necessary for identification.

In conclusion I must express the thanks of my party for the assistance, kindness and hospitality received by us all from Mr. Hildebrand, and the other officers, civil and military, whom we met in the Shan hills.

Report by MR. P. DORAN, *Extra Assistant Superintendent, on the operations of the Western Party of the* ANGLO-SIAM BOUNDARY COMMISSION, *Season 1892-93.*

In compliance with instructions from the Surveyor-General by wire, I joined the main body of the Commission at Nawngwaung on the 7th of December 1892. The Commission reached its destination, Möng Hang, on the 1st of January 1893. Here we found Mr. Stringer, Vice-Consul for Zimme, awaiting us, whilst the rest of the Siamese Commission were said to be waiting in their own territory.

The object of the Southern section of the Commission was to demarcate the boundary on the lines already laid down during the previous Commission. The duty which fell to my section was to improve as much as possible the topography of any ground the section should go over and which had already been surveyed; to improve the triangulation by observing to fixed and well-defined objects, and to get in as much new topography as

could be done. With this object in view, I sent off Mr. Shaw and Mahmud Hosein to clear and pole up certain hills which had already been fixed, and Mahmud Hosein was to assist him, as well as traverse any new roads that were gone over, and generally improve the topography which had been sketched from a distance. On the same date I accompanied Colonel Woodthorpe to Loi Kyilek and commenced my work from this station.

On January 7th the Southern section commenced its onward march. The members thereof were as follows:—

H. G. A. Leveson, Esq., C.S., Assistant Commissioner.
Captain H. B. Walker, Intelligence Officer.
Mr. P. J. Doran, Extra Assistant Superintendent, Survey of India.
„ H. G. Shaw, Sub- ditto ditto ditto.
Mahmud Hosein, Sub-Surveyor.
Ramsabad, ditto.
Sheikh Ali Hosein, Apprentice Sub-Surveyor.
L. Kamachat, Siamese Commissioner.
L. Sakal, Siam Survey Department.
Escort of 50 rifles of 22nd Madras Infantry.

Sub-Surveyor Ramsabad, who had preceded me to clear the hills Loi Htwe and Loi Mahang Kang, met me at Pongpakyien and reported that Loi Mahang Kang was inaccessible. Report had said before this that we would not be able to get up to this hill, that Mr. Ogle had failed in the previous season, and I was diffident of success when sending Ramsabad; for if Mr. Ogle failed, it was not likely anyone else could succeed. It was very necessary we should make this hill, Loi Mahang Kang, a station, and I attributed Mr. Ogle's not doing so to want of time. I regret that I also was unable to get up, particularly as this portion of the boundary required careful survey, the ground about here being one succession of devil's caldrons.

As Mr. Leveson wanted a larger scale survey of the country from Loi Htwe to Loi Mahang Kang, Sub-Surveyor Ramsabad was employed on it, and he successfully did enough to enable the Assistant Commissioner to select and lay down boundary pillars Nos. 1 and 2 without much delay. The work not being finished, Sub-Surveyor Ramsabad was left behind to complete it and join us later on.

We—*i. e.*, Mr. Leveson, the Siamese Commissioner, Survey Officer and myself—visited Loi Mehtaw on the 22nd January. The weather was unfavourable, but during the breaks the work required was done. Our next move was for Loi Saktaw. We started from Möng Hang on the 26th, and after every endeavour to get up to Loi Saktaw had failed, the Assistant Commissioner started for the Möng Pyien, trusting to a chance route from that side.

On the 28th January Captain Walker started to go *viâ* Me Pai (Möng Hpailon) to Mehawng Sawn. I took advantage of this opportunity, by sending Sub-Surveyor Ramsabad with him to bring in the topography of the Me Pai Valley and any other ground that he could traverse. The routes laid down for him, however, could not be traversed, as the Sub-Lieutenant in command of the Siamese escort objected, and though a good amount of fresh work was obtained, yet it fell short of what might have been done.

We reached Möng Pyien on the 29th, and met Mr. Shaw and Surveyor Mahmud Hosein by appointment, and found that the former had not been able to get up to Loi Saktaw from the Shan side. Loi Saktaw was abandoned. On the same day I met with an accident which at first threatened to prevent me from working for some time, but just then the Assistant Commissioner had to turn aside from the regular route which gave me time to recover, as I was able to remain behind with the main body which had been halted on my account. Mr. Shaw accompanied the Commissioner to boundary pillar No. IV, which was laid on the 1st of February.

After this, triangulation was simply impossible, though Mr. Shaw and I still continued visiting hills with the hope of being able to take the triangulation into the southern portion of the Karenni country, which had never been triangulated before. The haze was so great that the outlines only of hills four and five miles off could be seen. We reached Mehawng Sawn on the 14th of February, and the weather clearing up slightly, I sent off Mr. Shaw and Surveyor Mahmud Hosein to two different hills and started myself for a third in hopes of being yet able to get some triangulation into the South Karenni portion, but the weather again became unfavourable, and as time pressed, we returned to Mehawng Sawn on the 22nd.

On the 24th February Mr. Leveson and I started for the Me-sa-u stream, the junction of which with the Me Pai was to be marked. Mahmud Hosein accompanied me and carried on a traverse, till we reached Hkun Yom on the 5th of March. Captain Walker, in charge of the escort, marched direct to Hkun Yom, and I left Mr. Shaw with Sub-Surveyor Ramsabad and Apprentice Sub-Surveyor Sheik Ali Hosein to carry on the work by the route the Commission was marching. Mr. Shaw's party joined us on the 6th, and I was glad to find on comparison of the two tables that the position of Hkun Yom was almost identical.

From Hkun Yom we marched together to the village of Me-Ngaw on the Me Sawpa route, and camped a little on ahead. I had the whole party with me now, and to expedite the work my proposal that Ramsabad and Mr. Shaw should accompany the Assistant Commissioner, while I went on to Meche (or Me Se), was accepted, but as carriage was limited, Mr. Shaw accompanied me. We reached Meche (Me Se) on the 11th of March, and commenced work as soon as the weather allowed: there was a further delay in getting our elephants. Mr. Leveson and Captain Walker joined us on the 19th. We were ready

for them, and after finishing the work here we marched for the Salween and reached that river on the 22nd March.

The party, which now consisted of Mr. Leveson, Captain Walker, Mahmud Hosein, and myself, the rest having gone on with Mr. Shaw to Yua-thit, remained on the Salween for the 23rd and 24th March to enable me to have a look over the ground and survey the neighbourhood on the ½-inch scale which the Assistant Commissioner required. This was finished and the boundary pillar erected almost immediately opposite the junction of the Hpa Choung with the Salween on the left bank of the river, well above water-mark. After this we bade the Siamese officials farewell and encamped on the banks of the river about a mile north of our last camp. On the 25th March we started for Fort Stedman, which place we reached on the 9th of April.

The boundary pillars on the Southern section were invariably placed at points on the watershed, where it was crossed by a known road; the only exceptions were pillars X, XI and XVI, which are situated on the banks of the Me Pai, Me Hsulin and Salween, respectively, where the boundary leaves the watershed. The place selected for a boundary mark was always cleared, a hole dug in the centre of the clearing, and a marked stone placed on it, with a substantial pole erected over it.

My thanks are due to Mr. Leveson for his kindness and assistance during the time I was working with him.

The outturn of work done by this party was—

Topography	3,997 square miles.
Triangulation	2,500 „
Traverse	350 linear miles.

The traverse was plotted day by day as the work was brought in.

The country under report is entirely hilly and covered with dense jungle. Two prominent offshoots from the range on which the boundary runs are noticeable—the first from Loi Htwe, which runs almost due south and culminates in Chengdao, a cluster of pinnacled knolls, one of the highest and most conspicuous hills in the Siamese State; the second emanates from Loi Saktaw, and, splitting into two, encloses the valley of the Me Pai. The rest of the ground consists of long spurs breaking into intricate, irregular masses as they reach the plains.

The principal streams are the Me Ping, Me Ting, Me Pong, called further on Me Pai, Me Kong, Me Sangi, Me Sanga, and Me Hsulin. These, as they leave the hills, form valleys of which little can be said beyond that they are very poorly peopled and cultivated.

Möng Na, on the Me Ping, Möng Heng on the Me Ting, Möng Hpailong on the Me Pai, Napupawn on the Me Kong, Mehawng Sawn and Hkun Yom, are the chief villages. Of these Mehanwg Sawn alone can aspire to the title of town. It is situated in a pretty little valley and surrounded by hills. The town itself, which is well laid out in blocks and traversed by broad and well-kept roads, contains about 1,000 inhabitants, consisting of Shans, Laos, Siamese, Burmese, and Chittagonians. The shops are chiefly owned by Burmese and Shans. The Chinese seem to have some influence in the place. There are also a great number of timber merchants and they seem to be moneyed men. This place can also boast of a post office. Hkun Yom comes next in importance, and is only a largish village.

Teak, which was once plentiful, is now being fast cut down, and all streams capable of carrying timber down are fairly well stocked with logs awaiting the rains.

Report on the operations with the NORTHERN TRANS-SALWEEN EXPEDITION, *by* CAPTAIN T. F. B. RENNY-TAILYOUR, R.E., *Season 1892-93.*

I started from Mandalay on the 23rd November 1892, accompanied by Surveyor Ikbaluddin and reached Hsi Paw on the 3rd December. As Mr. J. G. Scott, the Superintendent of the Northern Shan States, intended to leave Lashio on the 1st December, I decided to cut across from Hsi Paw and join him at Man Ping in West Mang Lün; this arrangement suited me, for Mr. Scott was going almost entirely along the road taken when I accompanied Captain H. Daly in the season 1890-91, while by the route I now followed I was able to carry on a triangulation through country which had not previously been properly triangulated, and part of it had not even been mapped.

I commenced work on an old station called Loiyoi, about two marches before Hsi Paw. During the season I confined myself to the triangulation, while Surveyor Ikbaluddin did the plane-tabling.

My escort of 15 sepoys arrived in Hsi Paw on the 5th December 1892, and I left on the 6th, arriving at Man Ping on the 22nd. All the villages I passed through in West Mang Lün were deserted owing to disturbances in the State; and as Mr. Scott thought I might possibly be attacked, he sent me some reinforcements, but we met with no opposition, although we had considerable trouble at the ferry over the Nam Pang, where we found the boats had been removed, and we had to get bamboo rafts made to carry ourselves and the baggage across. At Man Ping I met Mr. Scott, and also Mrs. Scott, who accompanied her husband throughout the tour. The remainder of the party consisted of Lieutenant Erck and Mr. Hartnoll with about 120 Military Police; Lieutenant Ainslie, R.E., Intelligence Officer; Mr. Bradley, the Lashio Civil Surgeon, numerous followers and between 250 and 300 mules and ponies: we certainly looked a most formidable party.

Mr. Scott was delayed at Man Ping waiting for information about the Kachin rising in Northern Hsenwi, but on the 31st December he started off for Takŭt, the capital of East Mang Lün. While he was waiting at Man Ping, I was enabled to visit and form a station on a large hill called Loisè and took observations for azimuth at Man Ping itself. I also started off a couple of days before Mr. Scott, as I was anxious to obtain a good forward station a little way off the road. I rejoined Mr. Scott on the 1st January 1893 at Taman Hsum on the Salween river.

We arrived at Pang Yang on the 5th and at Takŭt on the 7th January. These places I had visited two years previously and had formed several stations in the neighbourhood, which I now again visited; and as the weather was clearer than on the former occasion, I was able to do much better work, and by fixing several distant hills managed to connect accurately with my triangulation of the season 1890-91 near and beyond Möng Len. This was of considerable importance, as, owing to the hazy weather then experienced, this triangulation had only been located by a plane-table fixing. The triangulation was, however, relatively accurate, for I had measured a base and observed for azimuth at Möng Len.

On the 8th January Mr. Scott halted and had a long interview with the Sawbwa of Mang Lün. On the 9th we started off to visit the minor State of Mawhpa, which is under East Mang Lün and situated at its extreme south along the Salween river. This State had never been visited before and was supposed to be extremely hilly, and the roads impassable for loaded animals; as we had only mule carriage I am glad to say we found the difficulties had been considerably exaggerated, and we not only got safely to Manpan, the capital, but returned to Pang Yang by another road. The people of Maw Hpa are civilized Was and very similar to those living in the main part of East Mang Lün. The capital, Man Pan, is a very nice-looking place, situated quite close to the Salween river. We left Man Pan on the 18th January, and got back to Pang Yang again on the 24th. Mr. Scott halted on the 25th, but I went on a march in front, as there was a hill I particularly wished to clear and observe from.

From Pang Yang Mr. Scott decided to march to Mot Hsamo, the capital of one of the small Wa States, on the Northern border of East Mang Lün. These small States were at this time engaged in fighting against the Mang Lün Sawbwa, and as we were informed that Mot Hsamo was very strongly stockaded and full of armed men, we were quite prepared for a fight. This, however, did not come off, as although we passed a number of stockades occupied by the Sawbwa's men, we found that Mot Hsamo itself had no special defences, and the people had no intention of fighting against us.

We arrived at Mot Hsamo on the 31st January and halted there for three days, as Mr. Scott wished to call in and interview the numerous chiefs in the neighbourhood. The States about here are ridiculously small, sometimes a single village declaring that it was independent, and had a Sawbwa of its own. Leaving Mot Hsamo on the 4th February, we arrived at Lün Long, the capital of a large Wa State of the same name, on the 8th. This place I had passed through two years previously, and on that occasion the Sawbwa was too frightened to come and see us; this year we found he had still no confidence in us and had run away, and although we stopped until the 12th, he never came near us. During this halt I was enabled to observe from a very good hill station and formed also a village station at which I observed for azimuth.

From Lün Long we marched to Möng Hka, which is a group of small villages occupied by a Mu Hsu colony, and situated in the centre of the wild Wa country. We arrived at the Wing, as the principal village is called, on the 16th February, and were met by several officials, preceded by a band and men carrying large flags. The Mu Hsus seemed a nice, quiet lot of people. Möng Hka is at an elevation of about 6,800 feet, and I was able to form two good stations in the vicinity, and from my observations a number of peaks in China will be fairly accurately fixed. While at Möng Hka our party was on the verge of starvation, as we had brought next to no rice with us, and only obtained some by sending out a forage party. Even then great difficulty was experienced in making the Was give it up. The scarcity of rice in these parts is owing to the fact that the people themselves live principally on millet and peas, growing little or no rice and only importing sufficient to make liquor with.

Leaving Möng Kha on the 20th February, we arrived at Möng Maü on the 25th. Möng Maü is a fine rich village occupied by Chinese Shans who had been driven out of the Chinese Shan State of Möng Tum. We here joined the road which I had gone along two years previously with Captain Daly. This was the end of our exploration amongst the wild Was, and we had probably seen and mapped quite half their country. Taken all round I think the wild Was are a good deal more civilized than we expected; the stories we heard of their being cannibals and living like wild men in the jungle without huts, are certainly unfounded. The people are all spirit-worshippers and offer up large numbers of buffaloes, pigs and fowls. On very special occasions, such as when they sow their fields, or if there is an epidemic of sickness, it is considered advisable to offer up a human head; these heads are obtained in the wild Wa country by sending out a head-hunting party, who catch any stray travellers they may come across and decapitate them. On the 22nd February, near Hsan Htung, we came on the bodies of three men lying on the road whose heads had been cut off a few hours before we passed. The Was near and to the west of Lün Long are said to be by the Shan "not so very bad," the principal difference being that they buy their heads instead of raiding for them. Just

before the entrance to nearly every village there is an avenue of large trees, under which posts or slabs of wood are stuck in the ground in a row, each of which has a hollow cut out of it, and it is in these hollows that the human skulls are placed; some villages had as many as 70 or 80 posts, and probably the majority of these have some time or another held a skull.

The wild Wa country is very hilly and wonderfully populous, the villages being numerous and very large, probably averaging 70 or 80 houses in each. The hill-sides are nearly all cleared for cultivation, and besides millet and peas a large area of ground is given up for the cultivation of the poppy for opium. To the east of Lün Long and Möng Hka, there are said to be very large silver mines, and also plenty of gold. The silver undoubtedly exists in large quantities, but we never saw a single piece of gold, not even on the women, who wear a great quantity of silver ornaments.

The villages in the Wa country are connected with each other by very good roads, but there is next to no trade, and the main road often runs right through the centre of the villages, which generally have tunnelled entrances; these were impassable for our transport, and we were often considerably delayed in getting round or cutting our way in and out of a village. We were on several occasions within an ace of having a row with the Was, but they were too much taken by surprise and unprepared to offer us much resistance; besides, the great apparent strength of our column must have impressed them. If, however, another column goes into their country, I think the chances are that there will be considerable opposition.

Leaving Möng Maü on the 27th February, we went by my former route to Pang Long, arriving there on the 2nd March. At Pang Long I left Mr. Scott's party, as he went on by the old route to Kun Long, while I returned to Lashio by a new road from Pang Long through Möng Kyek. This road, which is an excellent hill one, is always used by the Panthays when they come down to Lashio, and the ferry over the Salween river at Tahsupket is the best I have seen. We arrived at Lashio on the 15th March, and I stopped several days there to arrange work for Mr. Kennedy and his sub-surveyors up to the end of the field season. I eventually arrived in Mandalay on the 5th April 1893.

During the tour I managed to keep up a connected triangulation from my starting station on Loiyoi as far as my station on the 22nd February near Hsan Htung; after this the haze, which had been thickening for some weeks, became so dense that although I went up several hills, it was impossible to do any more triangulation. Surveyor Ikbaluddin did excellent plane-table work and mapped in a very large area of new country; as I was always able to supply him with fixed points, his work ought to be very accurate. I consider him particularly well suited to this kind of work.

I am indebted to Mr. Scott for the trouble he took in giving me the correct spelling of all names.

Extract from the Narrative Report of MR. J. M. KENNEDY, *Sub-Assistant Superintendent, 1st grade, on the operations in the* NORTHERN SHAN STATES, *Season 1892-93.*

In 1892-93 I was again, for the second time in the course of seven years, employed on ordinary work; this was in the Northern Shan States, where, as is generally known, the Kachins rose in December 1892, attacking places as widely apart as Myitkina and Theinni (Hsenwi) on the same day.

In camp at Hwèhok, three days' journey from Lashio, I received one morning at daybreak a letter from the *amat* (minister or agent) at Mongyaw, appealing for help, and stating that he expected an immediate attack by Kachins on his village. I moved over immediately with the greater number of the guard, forwarding the petition to Lashio with an intimation of what I had done. The following day I received a reinforcement of 30 men under Mr. E. Gabbet, Assistant Engineer, who happened to be the only European in Lashio at the time. After a halt of a day to rest these men, who had made the distance in one forced march, we moved out to meet the anticipated attack, Mr. Gabbet with his party of 30 men along the hills, I with 25 men down the valley,—having arranged to meet three days later at Möngkyet, a Shan village supposed to be occupied by the Kachins. I encountered the Kachins before arriving at Möngkyet, in five stockades, 2 or 3 miles west of that place, and with 15 men attacked and carried the position after sharp fighting, only one of our men being slightly wounded, while the Kachins (whom I met a month later) admit a loss of four killed.

The conduct of the guard, military police from Pyawbwè and Lashio posts, was beyond praise; and I trust that the report I submitted to the Commandant at Lashio may bring the men mentioned therein some recognition of their services. Havildar Boli Khan, who afterwards distinguished himself at Theinni, was with me throughout this affair; and Havildar Jowar Singh set an example in leading his men in the final rush on the stockades.

The following is a description of the affair in detail. On the 22nd December we left Hokai, and not anticipating meeting the Kachins this day, marched in the usual order, *viz.*, 15 sepoys with myself and the sub-surveyors in advance, an ammunition guard of four men, and six more in rear of the baggage. Two miles from the selected camp, Konghtan, we met a few armed Shans; though they attempted to evade us we

secured one of these as a guide. We entered Konghtan village, the houses appearing to be unoccupied, and there made arrangements for attacking the stockades (or stockade—for, till we came upon them, we had supposed there was but one). The Sikh Havildar, Jowar Singh, with seven men, was to advance by the left, or north, of the path, while I and the other Havildar, Boli Khan, with six men, attacked on the south.

The guide vanished after pointing out the large tree under which, he said, the stockade stood. The *khalásis* and sub-surveyors were sent into hiding in a wooded ravine to the west of the village, there to await the arrival of the baggage and ammunition guard; they were provided with three revolvers, a gun and some *dahs*.

On the arrival of my section opposite the third stockade, at a point where we could obtain a fair view of it, I saw, looking back, that the other section had not yet moved any distance out of the village; beckoning these on, I disposed my men on the fringe of the cover through which we had advanced, and allowing a reasonable time for the others to arrive, we opened fire. Our men firing volleys, the whereabouts of each section was fairly well known to the other. The Kachins immediately replied from Nos. 1, 2 and 3 stockades, and with a few shots from No. 5. We now for the first time learned of the existence of the other stockades. The Sikh Havildar advancing, directing his party on No. 3, suddenly found himself confronted by these, and firing a volley, promptly rushed them with the bayonet; my attack a little earlier had probably drawn the fire of most of the Kachins, so that the Havildar's party suffered no loss. The Kachins, breaking from No. 1, passed behind my men, firing four or five shots at us as they ran by at eight or ten paces. On the Havildar's party appearing opposite No. 3, we too advanced and entered that stockade together, passed through in pursuit, and on beyond Nos. 4 and 5, in which latter no stand was made. The stockades, which held from 15 to 20 men each, were found well provisioned with rice, beef and pork; some guns and *dahs*, too, were taken, and enough spears to equip most of the camp followers.

After selecting a site for the camp, and replenishing our stock of ammunition, we went out, an hour or two later, to pick up the odds and ends of clothing that our men had dropped in the course of the fight; to our surprise we found a party of 20 or 25 Kachins returning to the last two stockades. We drove these back and I then sent up all the followers with axes to destroy the stockades, which was done before evening.

The sub-surveyors report that at our first volley a number of men ran out from the village, which we had supposed deserted, and fired on them. These were most probably men from No. 1 stockade.

At Möngkyet, where we arrived next day, we found everything destroyed—villages, bazars and *kyaungs* burned, even the trees in the villages cut down; while in Möngkyet, where the Shans appeared to have offered a good resistance, were the mutilated and partially roasted bodies of two men and a woman, and some buffaloes. Mr. Gabbett's party came in an hour after us.

After two excursions into the hills north and north-west, we returned to Lashio, Mr. Gabbett being under orders to leave for Mandalay, while I could not keep the field with a reduced escort. On attempting to resume work in the direction of Theinni, I was met on the march out by thousands of armed Shans retreating from that place, which, they said, was invested by the Kachins. I sent forward a messenger who undertook to enter Theinni by night with a message for the Sawbwa, requesting him to hold out another day, when I should, in the course of my work, be with him. But the Sawbwa came into my camp the same night, leaving his stockades to be occupied by the Kachins, estimated to number 4,000 men.

Considering the occupation of Theinni a matter of little utility, even if it could be undertaken with my small force of 40 men, I was preparing to return when I received an unexpected addition to my escort of 50 men under Jemadar Jaffar Khan. In conjunction with this officer, we drove some 1,500 Kachins from Theinni and re-established the Sawbwa there.

The manner in which this was effected is as follows:—On receiving the above-mentioned reinforcements, we returned to Möngli, and next morning marched on Theinni, the Sawbwa, now attended by over 2,000 fighting men, continuing to retreat towards Lashio, and ridiculing the possibility of our being able to recover Theinni, which he said was held by 4,000 Kachins. He offered, however, to send four or five scouts in advance of our party to ascertain the state of affairs, and said we would receive their report at the stream before the village. These scouts never reappeared. One of the Sawbwa's officers, however, accompanied us as interpreter.

At Tsamlao Kyaung, a mile below the stream, a signal shot was fired by the Kachins, and coming out on the stream we found a few of them observing us from the further bank; we fired on these, killing one. From this point we could see an immense gathering of armed men on the site of the village of Theinni, the village itself having been just burned down, a few huts and granaries still smouldering.

Crossing the river and re-forming the men, we advanced across a mile of open fields, all under water, lying between us and the village. At about 150 yards from a stockade on the south of the village we halted. Some Kachins, 30 or more, here showed themselves on a high bank behind the stockade, and, from the way in which they exposed themselves, appeared to wish to parley. What they called out we could not ascertain; but the Sawbwa's man with us interpreted the speech as an insult and defiance, and the sepoys thereupon fired on these men and on the stockade in front. We pushed forward, passing through

and around the stockade, and found the main body of the Kachins, which had been concealed by the rising ground, streaming away in two large parties, about 600 or 700 going up into the hills to the north-west, a somewhat smaller body retreating to the north-east, and the remainder dispersing all around. The two large bodies of the Kachins were followed up by two parties of about 30 sepoys; some eight or ten men were left at the village with the reserve ammunition, and with these I moved up to the *kyaung* to the north of the village (since converted into a post). Here, while drying our clothing after the recent dash across the stream and a mile of wet ground, we were surrounded by bodies of Kachins, who, eluding the pursuing parties, appeared in thirties and forties round the *kyaung*; we sallied out after these, engaging the more adventurous of them hand-to-hand. In these little brushes we killed four, one with the bayonet.

The baggage now came up, bringing an additional 20 men, and a last attempt was made by the Kachins just then to re-enter the village from the east, but a party of 20 rifles which I hurried out to some cover about 100 yards off suprised and dispersed them, and we settled down at 2-30 P.M., having been skirmishing around since about 10 A.M. At about 3 P.M, the Sawbwa, who was probably waiting the course of events, came in, and half an hour later the Assistant Commandant from Lashio arrived with a few mounted men, the detached parties of our men coming in about the same time.

After a permanent post had been established at Theinni I returned to Lashio. We could not have penetrated further into the country without daily fighting with the Kachins, and orders had been received from the Civil Officer at Lashio not to provoke further fighting.

I shortly afterwards accompanied a party proceeding to meet the Superintendent, Northern Shan States, to report to Captain Renny-Tailyour as to the progress of the work, as well as to point out *en route* the places where opposition was likely to be encountered, and also to add to the survey which had been carried on throughout the other operations. On my return from this third expedition of the season, I resumed regular work in a more settled part of the country.

CENTRAL PROVINCES.

Extract from the Narrative Report of CAPTAIN W. J. BYTHELL, R.E., *in charge of No. 9 Party, Season* 1892-93.

The country, over which traverse operations were carried on during the past field season, presents many variations from the hilly, rugged area on the north of Bilaspur to the undulating plains of portions of the Raipur and Sambalpur districts. Almost the whole of the work lay in areas of wooded and jungly ground, and in all cases the line-cutting was heavy. The larger *zamindáris* of the Bilaspur district are situated on the spurs from the Maikal, Vindhya, and Korba ranges, which run south into the plains of Chhattisgarh, and here vast forests alternate with cleared and open valleys, from which the jungle has disappeared, and been replaced by thriving village communities. The villages, however, are very scattered, difficult of access in many cases, and generally convey no idea of permanence. The district is rich in archæological remains, such as temples, shrines, etc. The city of Ratanpur, once the seat of the Haihai Bansi kings and later of the Bhonslas, though its importance lapsed with the transfer of the head-quarters of the district to Bilaspur, is still full of interest. Its ruins cover an area of nearly fifteen square miles and contain within their limits a perfect forest of magnificent *pipal* and mango trees, amid the luxurious shade of which are scattered more than a hundred and fifty tanks of various shapes and sizes. On their banks are found many picturesque ruins of temples and shrines, together with large blocks of masonry sacred to distinguished *satis*. The largest of these, near the ruins of the old fort, marks the spot where, some 300 years ago, twenty Ranis of Raja Lachman Sahi immolated themselves. The temples in the district are very numerous and testify to the great antiquity of the Hindu government, the majority being at least 800 to 1,000 years old. The most ancient of these is that of Baramdeva at Chápa, near Kawardha, which, if the date on its tablet may be relied on, was built in the year A.D. 103, and the best specimen of architecture is that of Pali, on the road between Ratanpur and the hill fort of Laphagarh.

The *zamindáris* of the Raipur district, which came under traverse survey during the past field season, are situated along the edge of the district and on the eastern bank of the Mahanadi. From Deori *zamindári* on the north to Khariar and Bindra Nawagarh on the south, the country is generally hilly and covered with jungle. The hills, though, are generally low, rarely rising beyond 1,690 feet; they are covered with dense jungle and are but scantily populated. In this district it was found possible to run the sub-circuits along the foot of the hills, as the whole of the work lay in the undulating valleys, which, in fact, are the only cultivated and inhabited portions of the country. These valleys are much cut up by small *nalas* and water-courses, and nearly the whole face of the country is covered with jungle. The commonest trees are the *sál*, teak, *mahua*, *bijesál* and *shisham*; whilst in the hill ranges to the south of Bindra Nawagarh there are large forests of *sáj* and *tendu*.

In Sambalpur, the *zamindáris* containing the villages traversed are situated in a rough circle surrounding the *khalsa* lands of the district. The country may be

described as an undulating plain with rugged ranges of low hills rising in every direction. The largest of these, the Bara Pahar, is situated in a bend of the Mahanadi, and an offshoot trends south-west into Phuljhar dividing that *zamindári* from Borasamar. The *zamindáris* of Kharsal and Pahar Sirgida also abut on it to the north. As in Raipur, the sub-circuits were generally run clear of the hills, and the traverse work lay in the undulating valleys, where jungle and forest have been largely cleared, patches of mango, *mahua* or *sál* trees being left, thus giving the country a picturesque park-like appearance. As in Raipur, the commonest trees are the *sál*, teak, *sáj*, *bijesál*, and *mahua*.

BOMBAY FORESTS.

Extract from the Narrative Report of COLONEL H. S. HUTCHINSON, S.C., *in charge No. 17 Party, Season 1892-93.*

In the Northern Circle, the detail survey in Salsette, Bassein, and Bhiwandi *talukas* of the Thana district was done under the supervision of Mr. S. F. Norman during March, April, and May 1893. The ground is hilly and covered with mixed teak and evergreen forest, and its delineation on so large a scale as 8 inches to the mile was of considerable difficulty. It was situated mostly on what is called the Tungar and Kamandrug range of hills, a locality of considerable interest.

In the Central Circle, the ground surveyed in the *babul* reserves on the Bhima river in the neighbourhood of Indapur, falling into the Poona and Sholapur districts, was flat and most of it poorly wooded, though some of the blocks contained closely grown and valuable *babul* timber. The blocks were not very much scattered, and some of them were large, whilst the details on the ground were few, so that a fair area was surveyed pretty rapidly.

The survey of the *babul* reserves on the Bhima and Panna rivers in the Khed and Mawal *talukas* of the Poona district (Central Circle) was done under myself and Mr. C. Norman. The area consisted mainly of fringes of *babul* growth on the banks and was much scattered, so that the sub-surveyors lost much time in moving from one bit of work to another. The character of the ground was mostly hilly and raviny, whilst the attenuated and contorted shapes of the blocks involved a good deal of survey, but enclosed very little actual forest area. The survey of the *babul* reserves on the Nira river in the Bhimtadi *taluka*, Poona district, much resembled that described above, and there is very little actual forest area to show for a considerable amount of survey and labour done.

In the Junnar *taluka*, Poona district, where 8-inch topographical survey was carried on, the ground is most of it mountainous and rugged in the extreme, and also raviny, but being almost bare of forest there was no difficulty in seeing the features of the ground, some of them on a very vast scale and of most extraordinary shapes and admitting of survey in great minuteness of detail; it has been excellently rendered and the maps are perfect pictures of the ground.

In the Southern Circle, surveys on the 4-inch scale were carried on in the Supa *taluka*, North Kanara district. The ground is very varied in character, embracing mountainous country, and elevated plateaux with deep ravines, the latter often filled with tree forest and dense evergreen undergrowth or with *karvi* (a reed that grows as close as sugarcane, and to a height of 13 feet).

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The following hill forts came under survey in the Junnar *taluka*, Poona district: Shivner, Chawan, Judhan, Hadsar, and Dhak.

Of these Shivner fort is perhaps the most interesting. It is built on a rocky hill that rises over a thousand feet above the plain of the Junnar valley; it is triangular in shape, and is crested with a scarp of rock ranging from 100 to 200 feet in height. The scarp commences about 600 feet above the valley and rises like a perpendicular wall, needing but little aid from man to make it a most formidable fortress. Lower down the hill there is another horizontal stratum of rock, but of less height, averaging about 40 feet, but in places disappearing altogether under the slopes of the lower spurs of the hill. At the foot of the upper and lower scarps are lines of old Bhuddist caves; they are of no very great size, and some of them are more suited as dwellings for vultures than monks. Above the upper scarps the hill rises to a rounded summit crowned with a mosque, a tomb and an Idga. The natural rock of the hill is most broken on the south face, and this is consequently the easiest approach to the upper fort. For this reason it has been most strengthened by outworks and bastioned walls. The fort is interesting as exhibiting signs of occupation by five sets of proprietors,—*viz.*, Bhuddist monks, early Hindu kings, Musalmans, Marathas, and English. During the 1st, 2nd, and 3rd centuries A.D. the hill seems to have been a great Bhuddhist centre. About 50 cells and chapels remain cut into the sides of the hill, most of them on its eastern face, besides many rock-cut steps on the rocky portions of the face of the hill. Again, broader, deeper steps and four or five water-cisterns show that before Musalman times the hill was used as a fort by Hindu kings; whilst the pointed arches of the gateways and nearly all the fortifications are of Mahomedan origin (besides the prayer wall-tomb and mosque, as well, perhaps, as some of the water cisterns). Of the Marathas there are but few traces beyond repairs

to the walls and the shrine of Shivabai. The only signs of English occupation are some olive and teak trees. The hill rises immediately on the south-west side of Junnar city, and the road from the city to the fort skirts the eastern face of the hill, and, after passing through the Pirpadi pass, turns sharp to the west, ascending the southern face. The road is crossed by a succession of gateways, protecting the approach with flanking walls barring the way wherever the natural hill is at all accessible. After passing through four of these gates the path turns to the right, climbing the face of the hill by rock-cut steps. This part of the ascent is right in front of and exposed to the fire of the Shivabai (or 5th) gate. Inside this gate the hill still rises over sloping rock to an inner wall about 30 feet high, or the 3rd line of fortifications. To the right of the Shivabai gate inside a parapet wall, a path, leading the way up the hill to the left, leads along a level terrace to a small arched gateway, which is different to all the rest, having scalloped edges, flowers and leaves carved on its face; this leads to the temple of Shivabai, which stands on a masonry plinth and is built against the rock of the hill; a hollow in the rock serves as a kind of shrine or holy place in which the light of the temple is kept burning. To ascend the hill you have to return to the Shivabai gate, whence a path turns to the left by old and well worn rock-cut steps which pass between two rock-hewn reservoirs, to the 6th or Phátak gate, the approach to which passes under a wall of rock about 20 feet high, covered by a masonry wall about 12 feet higher. To the left of this gateway are the remains of a ruin with a window facing southwards, and about 30 yards to the west of the 7th gateway there is an avenue of olive trees leading to a plinth which marks the site of what was once a large building known as the Commandant's house. The trees were planted in 1841 by Dr. Gibson, the first Conservator of Forests, who used to spend some months each year on the hill. The hill-top forms an isosceles triangle, the southern face of which forms the base. In the centre is the upper hill top, a steep mound about 250 feet high, steep towards the east, and with a gentler slope towards the west and north; whilst at the northern apex of the triangle is a considerable belt of nearly level ground. The east hill face has a line of young teak trees immediately under the shelter of the upper hill and above the main scarp of the lower hill; these also are said to have been planted by Dr. Gibson. From about the middle of the east face there is said to be a footpath making a short cut to Junnar, but I should be sorry to attempt it in its present condition. On the upper hill summit there is an Idga and a domed Musalman tomb. On the flat ground near the northern apex of the fort is a mosque with two minarets and a flying pointed arch between them; immediately in front of the mosque which faces eastward is a flight of steps leading to what must formerly have been an immense rock-hewn reservoir of water. From the western wall of the cistern the rock is excavated below the mosque itself, forming an inner and covered reservoir; this is the finest tank of the kind I have seen anywhere. The walls are cleanly and squarely chiselled out. It is 80 feet long by 40 wide and about 16 feet deep; two square-cut pillars help to support it in the centre. It is in good repair, and when I saw it contained about 3 feet of water.

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of COLONEL J. WATERHOUSE, S. C., *Assistant Surveyor-General, Season 1892-93.*

OUTTURN.—The outturn in almost all sections again shows a very large increase, amounting in the case of the work done by the lithographic and zincographic presses and machines to an increase of more than 25 per cent. of the outturn of the previous year. An abstract of the work done is given in the statements appended.

ORIGINAL SUBJECTS.—The number of original subjects under reproduction during the year has been 8,365, or 833 more than last year. Of these, 589 have been lithographed, only 51, or 37 less than last year, being departmental, and 538 extra-departmental, or 1 less than last year. The remaining 7,776 subjects were reproduced by various photographic processes or by zincography, and comprise 1,044 departmental, 5,597 cadastral, and 1,135 extra-departmental subjects. Last year the numbers were 1,064 departmental, 4,956 cadastral, and 885 extra-departmental subjects, showing differences of *minus* 20, *plus* 641, and *plus* 250, respectively.

From this it appears that while there has been a slight falling off in the ordinary departmental work in hand, there has been a large increase in the cadastral and extra-departmental work. The actual number of sheets of maps, etc., received during the year was 8,508, of which 1,382 were departmental, 5,623 cadastral, and 1,503 extra-departmental, while the number completed and despatched was 7,134, of which 650 were departmental, 5,420 cadastral, and 1,064 extra-departmental.

LITHOGRAPHIC DRAWING SECTION.—The total number of new drawings, or additions, etc., made to maps on stone, taken up and completed during the year, was 423, of which 33 were departmental and 390 were extra-departmental. Last year, 577 subjects were completed, of which 77 were departmental and 500 extra-departmental. The section has been under charge of Mr. H. L. Lepage, the Head Assistant. Under the new organisation, the *personnel* of this section was somewhat modified and has been strengthened by the appointment of a head draftsman and six colourists. The four zinc correctors formerly attached to the normal zinc printing section have been transferred to this section

and will be eligible for promotion in it. It is also intended that all young draftsmen shall in future be trained, as far as possible, to work either on zinc or stone.

LITHOGRAPHIC AND ZINCOGRAPHIC PRINTING SECTION:—In the re-organisation of the office, the *Press establishment* of the Lithographic Office was amalgamated with the *Zinc-printing section*, normal; but as yet the work of the stone and zinc printing presses is kept separate because the two classes of work require different training. In the machines, however, zinc plates or stones are worked indiscriminately, as required. The staff of the two sections was strengthened by the appointment of a machine printer and an assistant zincographer, both on salaries of R75 rising to R125 per mensem, 9 machine men, an engine-driver and fireman required to work the machinery, and one apprentice. Mr. B. Mackenzie, the senior zincographer, was appointed head printer on a salary of R350. Mr. J. B. Mackenzie was transferred from the cadastral establishment to fill the new post of assistant zincographer. The machine printer's post was not filled at the end of the year owing to difficulty in finding a suitable man on the pay, but it has since been filled by the transfer from the photographic negative section of Mr. Michael, who had been learning the work of the machines.

The new quad-crown lithographic machine was started in March 1893, being placed under charge of Mr. Deas, the chromo-litho. printer, who is well acquainted with machine-work, while Mr. E. A. Le Franc took charge of the general work of the lithographic presses. Having a good knowledge of zinc printing, he is able to make transfers to one or the other as may be most convenient, and this is a great advantage. The new machine, though of a much lighter and less expensive pattern than the first, has worked very satisfactorily and required no extra power or any change in the driving arrangements of the engine beyond the extended shafting. The additional printing power gained by it has greatly relieved the pressure of printing work, which was very severe during the first few months of the year. With the three machines there is now no great difficulty in getting through the work, except when several orders are urgently required at the same time. Without this machine it would have been quite impossible to have got through the work we have done. The number of subjects printed from stone was 543, or 2 more than last year; of these, 33 were departmental and 510 extra-departmental, against 63 departmental and 478 extra-departmental of last year. The number of pulls from stone was 555,372, showing an increase of 128,717 over last year. The number of copies printed was 506,897, or 158,744 more than last year. 159,322 copies were coloured, showing an excess of 53,750 over last year. The above figures show that stone still keeps its place in the office and is largely utilised for colour work.

The number of zinc plates printed was 1,214, of which 624 were departmental and 500 extra-departmental. The number of pulls was 309,287 (109,001 departmental and 200,286 extra-departmental) and of complete copies 349,075 (107,190 departmental and 241,885 extra-departmental). Last year, the number of plates printed was 942 (333 departmental and 609 extra-departmental), pulls 179,434 (48,104 departmental and 131,330 extra-departmental) and copies 254,285 (53,767 departmental and 200,518 extra-departmental). This shows a total increase of 272 plates printed, of 129,853 pulls and of 94,790 copies. It may be noted that this year the number of departmental maps printed from zinc was considerably greater than the extra-departmental, and while the number of pulls for both kinds of work had largely increased, the increase was greatest for the departmental work.

CADASTRAL ZINC-PRINTING SECTION.—5,442 plates of cadastral maps of the North-Western Provinces, Burma and Assam were printed off, the number of pulls being 162,023 and of copies 151,213, as against 4,966 plates, 149,979 pulls and 139,819 copies, showing an increase of 476 plates, 12,044 pulls and 11,394 copies.

The changes in the organisation of the cadastral zinc-printing section were comparatively trifling, and while providing increased pay for the posts of assistant zincographer and one of the zinc correctors, and for increases in the number of spongemen and zinc grainers, they effected a small saving in cost by reduction in the number of pressmen. Mr. G. A. Le Franc, one of the passed apprentices, was appointed assistant zincographer, and on the transfer of his brother to the lithographic printing section, was placed in charge of the cadastral presses, being assisted by Mr. P. Michael, another passed apprentice, who was transferred from the photographic section to the zinc-printing to meet the stress of printing work.

TYPE-PRINTING SECTION.—The number of items set up was 11,210, or 2,575 more than last year, showing an increase of about 29·8 per cent. This very large and unexpected addition to the work is principally due to the much larger number of type headings and footnotes required for the departmental maps photo-zincographed and the extra-departmental maps and drawings lithographed, and has been almost more than the composing staff have been able to meet, and if it continues, some additional compositors must be taken on.

The number of pulls was 1,448,607 and of copies 693,668, against 1,318,597 and 678,968 of last year, showing an increase in the number of pulls of 100,010 and in the number of copies of 14,700, which, though not so great an increase as last year, is still a considerable addition.

The chief changes in the organisation of the type-printing section were an increase to the maximum pay of the post of Head Printer, rom R100 to 150, and the provision of two type-machine-printers on R20 and 15 and two machine inkmen on R8. As no very large increase in the composing work was anticipated, no additional compositors were provided, but this will probably now have to be done.

PHOTOGRAPHIC DIVISION.—Under the new organisation, the negative, photo-transfer printing and silver printing sections have all been amalgamated into one list for purposes of grading, but it will be more convenient to consider the working of each section separately as heretofore.

NEGATIVE SECTION.—The total number of negatives taken during the year was 6,946, including 42 negatives and 89 transparencies required for the heliogravure process. Of these, 1,552 were departmental, 4,203 cadastral, and 1,191 extra-departmental. Last year the numbers were 1,440 departmental, 3,634 cadastral, and 1,079 extra departmental, showing an increase this year of 112 departmental, 569 cadastral, and 112 extra-departmental, or altogether 793 negatives. The section has remained under charge of Mr. H. Haward and there have been no changes in the processes. Mr. C. DeCruz was dismissed on the 24th August 1893 for drunkenness and irregularity of attendance; he had been repeatedly warned. Mr. F. U. Murphy was appointed assistant photographer on the 3rd April 1893 and has made very good progress in learning the work.

PHOTO-TRANSFER PRINTING SECTION.—The number of photo-transfer prints prepared was 6,278, of which 1,367 were departmental, 3,983 cadastral, and 928 extra-departmental. Last year, the numbers were 1,049 departmental, 3,648 cadastral, and 1,032 extra-departmental, showing an increase of 318 departmental, 335 cadastral, and a decrease of 104 extra-departmental, or a total increase of 549. This section has remained under charge of Mr. J. Harrold and there have been no changes either in processes or *personnel* to record.

SILVER PRINTING SECTION.—The number of silver prints made during the year was 1,269, against 2,998 of last year, showing a decrease of 1,729; but, on the other hand, the number of blue prints taken for proofs and other purposes shows an increase of 426, the number printed being 2,892 against 2,466 of the year before. The work of the section is carried on by Mr. C. J. Meade, who has been appointed an Assistant Photographer on R75 to 150 under the new re-organisation.

HELIOGRAVURE SECTION.—This section, under the supervision of Mr. A. W. Turner, again shows a large increase of work all round. Eighty-five plates were prepared by the photo-etching process and 61,082 copies printed during the year, showing an increase of 35 in the number of plates and of 18,667 in the number of copies as compared with last year. Eighty photo-blocks were produced, or 23 more than last year, and 19 matrices and duplicates were electrotyped, against 14 of the previous year. Three plates were corrected by electro-deposition of copper. No changes of any importance have been made in any of the processes in use.

The D copper-plate-printing press, worked by steam, has been found exceedingly useful in getting through the printing work, and now that the difficulties at first experienced in getting a proper pressure have been overcome, it proves to be equally adapted for line or half-tone work, and a large number of the delicate plates of the Bower Manuscript have been printed in it. A specimen of the ordinary work of the section is given as a frontispiece. It is a reproduction from a negative by Major Gore, R.E., representing the Shainsar Temple, Kulu.

Further trials have been made of the method of reproducing brush-shaded maps and printing them in colours by heliogravure, referred to in last year's report. As there was some difficulty in obtaining suitable brush-shaded drawings, the art having to a great extent become disused and the draftsman out of practice, a method was tried of drawing the hills on ground glass with a black creta-levis pencil, which drawing then serves at once as the positive transparency for obtaining the image on the copper-plate. This plan was found to answer perfectly, and a specimen of a map produced in this way and printed in three colours is given at page 108 of the Report.

The method of preparing the three plates is as follows:—

The outline is etched in the ordinary way on a copper-plate by itself and then from the same transparency as was used for this plate a second tint-plate representing the water is produced; this is done by masking out on the transparency with Indian ink all the parts representing the water, except smaller rivers. The outline is then scraped off with a penknife, thus leaving the land part of the map transparent glass and the water opaque; from this the blue plate for the water is etched. The third plate for the hill shading, to be printed in brown ink, is produced as follows:—A dry print on tissue paper taken from the outline plate is attached to the smooth side of a sheet of ground glass and the hill shading is then drawn in reversed style with a black chalk pencil on the rough side, a retouching desk being used for this purpose; from this drawing the hill-plate is etched direct, the drawing, in fact, taking the place of a transparency. The three plates are printed in black, blue, and brown on "Art" paper, used dry and registered, as in chromo-litho-printing, with needle points.

The method appears to be quite practical and applicable to high class map-work, for which it could well replace lithography with the advantage of the copper plates standing a very much larger number of impressions and allowing greater facilities for correction.

Some new ruled screens for photo-block work have been received from England, but have not yet been made much use of, as there has not been much large block work coming in. A convenient method of adjusting the screens in the camera has been adopted from a model made by Mr. Haward, Head Assistant in charge of the Negative Section.

By means of a rack and pinion connected with an index the screen can be moved backwards or forwards any distance in front of the sensitive film. A specimen of a print from a block produced with the aid of this apparatus is attached and is from a negative taken by Captain Bower, representing a dance of Buddhist monks at Leh.

The method of correcting engraved copper-plates by electro-deposition, which was described in the Annual Report for 1872-73, has again been tried for the correction of some important plates which it was undesirable to damage by beating up the copper. Though the results were successful, there are still some difficulties in applying the method practically, and especially where scattered corrections have to be made over a large surface. The method first tried was exactly the same as described in the Report referred to. The copper plate to be corrected is first coated with a thin asphaltum varnish, and the parts to be corrected are cut out. The plate is then covered with a good coating of Brunswick black to within a very short distance from the edge of the cuts. When this is dry a wall of bordering wax about 1½ inch high is placed round the part containing the cuts, at 2 or 3 inches distance from them, and a slightly acid solution of sulphate of copper at about 16 per cent. is poured into the trough so made. A piece of copper large enough to cover the cuts and connected with the copper pole of a Menotti's cell is then placed over the plate at about half an inch away from it. The zinc pole of the cell being then connected to a bare corner of the copper plate to be corrected, deposition of copper in the cuts begins and fills them up completely in the course of 18 to 24 hours. When the deposit is slightly above the surface of the copper plate, the operation is stopped, and the wax wall and varnish being removed, the deposit is carefully filed down and scraped away till the level of the plate is restored. In the first plate tried the connection between the deposited copper and the engraved plate was not sufficiently perfect, and in some places there was a fine line left between them. In the next trial the engraved plate was silvered and the parts to be corrected cut away. It was then well cleaned with caustic potash, washed and dried off with clean blotting paper and the whole plate coated with black varnish to within one-sixteenth of an inch of the parts cut away for correction. This method was found to answer better and a perfect join was obtained when the plate was small or the corrections close together, but it was not so successful with large plates or where the corrections were much scattered, which is generally the case; the difficulty being to arrange an anode with a surface approximately the same as the exposed surface of the corrections, and at the same time to spread over the whole surface of the plate in which the corrections occur. Mr. Turner tried an ingenious arrangement of thin copper bands twisted together roughly into the shape of the parts to be corrected, but it was found better to have an anode formed of a copper plate of good thickness and of the size of the plate to be corrected, but painted all over with black varnish except in such parts as came over the portions of the engraved plate upon which the deposit was required. In this way the proper proportion between the surface of the anode and of the parts to be deposited upon can easily be secured and maintained, while at the same time a large and fairly thick copper plate can be used for dissolving. As the results were not uniformly successful, the method was put aside for further trial, but there is little doubt that if care be taken not to attempt to cover too large surfaces at once, and in the case of large plates to carry out the corrections in one or two groups of a convenient size, the method could be quite successfully worked and would be of great value for the correction of engraved plates containing hill work or other close and delicate work liable to be injured by the usual process of beating up.

In the new organisation the photo-collotype section has been abolished and the establishment amalgamated with the heliogravure section, which has been reorganised and strengthened as far as possible, to meet the increasing demands upon it. Two assistant photo-engravers have been appointed, one on ₹100 to 200, and the other on ₹50. Mr. J. T. Meade, who was formerly collotype-printer and has now attained a fair proficiency in photo-etching and block work, has been appointed to the first of these posts, and Abdool Rahman to the other. A second engraver has been appointed and one additional copper-plate printer and six pressmen, plate-polishers, etc., were added to the section and are sufficient to meet present demands. Mr. Gonsalves was taken on as an apprentice under the new organisation and is learning the work satisfactorily.

EXPERIMENTAL AND PERSONAL WORK.—The increasing amount of office work leaves but little leisure for steady experiment, and the unusually wet and dull weather during the greater part of the year were also unfavourable to work of the kind. Trials were made of the new developers, Amidol, Metol, and Glycin. The two latter appear likly to be very useful substitutes for pyrogallic acid in developing dry plates, though we have lately gone back to the use of ferrous oxalate for copying purposes in connection with heliogravure. With proper exposures it gives good density and clear negatives. An instance occurred during the year showing the value of orthochromatic plates for copying maps printed in colours, which would be quite impossible by the ordinary process. Copies were quickly required of a map on which the hill features were shown in burnt sienna and the streams in blue. Taken in the camera by the ordinary wet collodion process, the hills were perfectly black and obscured the names, while the streams were not traceable. By using dry plates, orthochromatised as described in last year's report, together with a deep yellow glass screen, photographed copies were obtained showing quite clearly and legibly the black outline and names, the brown hills and the blue streams, and from these photographs the map was afterwards redrawn and photo-zincographed. During my privilege leave in Europe I took the opportunity of making enquiries about various matters connected with

Photo. Block. S. I. O., Calcutta, February 1893.

MASKED MONKS — LEH.

the office work, chiefly to find a thin printing paper suitable for colour-printing in the machine. The bank post paper we generally use is so hard that it is very difficult to print it dry for colour work. Other thin papers were found to distort. Samples were obtained from Messrs. John Dickinson & Co., and some of their papers have been indented for for trial. Enquiries were also made about a new lens required in the heliogravure section for copying work. Under the advice of Messrs. Ross & Co., choice was made of the new Goerz double anastigmat form which has unsurpassed powers of covering a suitably-sized plate quite sharp up to the edges and at the same time works with fair rapidity, because a larger stop can be used than with lenses of the ordinary type.

I have continued my experiments on electric currents in developing: also on the electrical action of light on silver and its haloid compounds, and a preliminary paper containing some of the results of the latter enquiry was published in the Journal of the Asiatic Society of Bengal. In the course of these experiments, a method of oxidising silver was found, which appears to be new, and may have some useful practical applications. If a plate of silver is placed in a vessel of distilled or ordinary water in connection with a single Meidinger cell, so as to form the anode, another plate of silver or platinum forming the cathode, when the current passes a bluish-black reguline deposit will be formed which is quite adherent and bright. A low current is required for this work; with a stronger battery the deposit is granular and browner.

In August the opportunity was taken of my going on privilege leave for me to visit Poona to inspect the fair drawings of Nos. 10 and 17 Parties, and with the kind permission of the Superintendent, Mr. T. Le Messurier, I was able to see the Government Photo-zinco. Office.

The following extracts, which bear on the general increase of the work that has arisen in the office, and which were adduced to show the necessity for the reorganisation and increase of establishment, as recently sanctioned, are given for convenience of future reference.

Extract from a letter from COLONEL J. WATERHOUSE, *Assistant Surveyor-General, to the Surveyor-General of India, No. 838 P. L., dated 25th June 1892, on the reorganisation of the Photographic and Lithographic Office.*

* * * * * * * * *

3. As a special grant is given for the maintenance of the establishment required for the reproduction of Cadastral Maps, it will be necessary, as heretofore, to preserve a distinction between the "*Cadastral*" and "*Normal*" Establishments. The former will remain on the same footing as at present. The latter will include the ordinary or "*Normal*" Establishments of the Photographic and Lithographic Offices combined, but arranged, for convenience in drawing pay-bills, etc., in two divisions, *viz.*:—

I.—The "*Lithographic and Printing Division*," comprising the following sections:—

(*a*) Lithographic Drawing.
(*b*) Lithographic and Zincographic Printing.
(*c*) Type Printing.

II.—The "*Photographic and General Division*" comprising the following sections:—

(*d*) Photographic Negative and Printing.
(*e*) Heliogravure.
(*f*) Correspondence, Stores, and Accounts.
(*g*) Servants.

The *Cadastral Establishment* will form a third Division, comprising the following three sections:—

(*h*) Photographic.
(*i*) Zincographic Printing.
(*j*) Office Establishment and servants.

4. There would accordingly be in future one Budget Estimate for the combined "*Normal*" Establishment and one for the "*Cadastral*" Establishment, and all statements of account and returns, etc., in which the distinction between "*Normal*" and "*Cadastral*" is necessary, would be treated in the same way; but in all other cases, as for Annual Indents, Annual Reports, etc., they would be still further combined so as to include the whole Office.

5. At present I hold three permanent contingent advances, *viz.*:—

(1) Rs. 200 for the Lithographic Office,
(2) Rs. 200 for the Photographic Office (*Normal*),
(3) Rs. 300 for the Photographic Office (*Cadastral*);

but in future it would be necessary only to have two,—*viz.*, Rs. 400 for the "*Normal*" and Rs. 300 for the "*Cadastral*" contingent expenditure. Contingent bills would be drawn against Budget grants under the same two heads.

6. The annexed statements of present and proposed establishments show the details of the changes I propose in the establishments in order to carry out the above redistribu-

tion, and to render the Office more efficient than it is at present by providing the necessary establishment for working the new steam machinery and making other modifications in the establishments which experience has shown to be needful.

7. Before proceeding to discuss these details and the necessity for the various changes proposed, it seems desirable to draw attention—

(*i*) To the enormous increase to the work of the Office throughout since the time when the present establishments were sanctioned, and more especially to the largely increased demands for lithographic and photographic work from other departments.

(*ii*) To the increasing value of the work done as compared with the expenditure, and the savings effected by the concentration of the Offices and the introduction of steam machinery.

Impossibility of carrying out reductions owing to general increase of work.

8. It may be well also to state that it has not been found feasible to carry out the reductions anticipated in my letter No. 877L. of 21st September 1888. At the time that letter was written, I had no experience of the working of steam printing machinery, but naturally anticipated that its introduction would enable some reduction to be made in the number of hand presses and printers, though this, in any case, would only yield a comparatively trifling saving. When, however, the machinery was introduced and set working, it was found that the demands upon the Office for printed work increased so fast that there was constant work for the two steam litho.-machines and for nearly all the hand-presses besides, as was reported in my Annual Reports for 1889-90 and 1890-91; and this is still the case, though 3 hand-presses have been reduced. In the letter referred to, I, to some extent, pledged myself to work the steam machinery without increased expenditure on establishment, and this promise I have so far carried out. In now reorganising the Office upon a permanent basis to enable it to meet these largely and steadily increasing demands upon it, I have made every effort to keep the expenditure within present limits, but have found it quite impossible to do so, having regard to the increase of work all round and other necessary requirements of the Office, as will be fully explained further on. The concentration of the Offices has enabled some petty reductions of servants to be made, and made the work of supervision easier and cheaper, but it has not in any way lessened the amount of work to be done by the technical and clerical staff, and consequently no large reductions have been found possible.

9. From the accompanying Table A, which shows the amount of work turned out in the Lithographic and Photographic Offices at intervals of 10 years from 1868-69, as well as for the past two years, it will be seen how enormously the use of photography and zinc-printing has increased during that period, and the latter more particularly during the past two years since the introduction of steam power in 1890.

A.

Statement showing the Increase in the Work and Outturn of the Photographic and Lithographic Offices at 10-yearly intervals from 1868-69 and during the past 2 years.

		1868-69.	1878-79.	1888-89.	1889-90.	1890-91.
ORIGINAL SUBJECTS	Litho.	271	445	803	645	662
	Photo.	578	811	1,150	1,742	2,039
	Cadastral	...	4,352	3,587	4,548	4,376
LITHOGRAPHIC PRINTING	Sheets	355	445	652	633	681
	Pulls	111,684	139,366	342,820	286,564	283,819
ZINCOGRAPHIC PRINTING	Transfers (Normal)	487	653	643	1,041	1,127
	Pulls "	34,059	94,623	123,267	209,634	276,602
	Transfers (Cadastral)	...	4,537	3,642	4,499	4,484
	Pull "	...	123,700	103,882	108,799	151,557
TYPE PRINTING	Items	...	1,993	6,646	9,918	9,098
	Pulls	224,280	367,175	1,177,175	1,061,577	1,074,280
PHOTO-NEGATIVES	Normal	1,784	1,322	1,977	2,359	2,483
	Cadastral	...	3,401	2,819	3,241	3,211
PHOTO-TRANSFER PRINTS	Normal	2,273	1,180	1,692	1,918	2,322
	Cadastral	...	3,359	2,821	3,230	3,257
SILVER AND BLUE PRINTS		3,773	463	1,485	3,002	3,796
HELIOGRAVURE	Plates	...	...	50	56	70
	Prints	...	...	20,307	30,389	34,015
ELECTROTYPES		...	...	12	17	26
PHOTO-BLOCKS		...	...	...	6	35

10. I have selected 1868-69 as a starting-point, because it was in that year that the Photographic Office fairly began work in premises at all fitted for the purpose and with the original "*Normal*" Establishment, which in the most important sections was practically much the same as at present. The establishment of the Lithographic Office was also placed substantially on its present footing in 1866, and consequently was in regular working order in 1868-69. At this time lithography was in full use for departmental maps and forms, and for a considerable proportion of extra-departmental work, amounting to nearly two thirds of the total printed outturn. Photo-zincography, which was first introduced in 1865, was just beginning to be worked in a practical way, and to be utilised for the reproduction of departmental maps as well as for a small amount of extra-departmental work, the total number of "Miscellaneous Maps," which no doubt included many departmental subjects, being only 133 with 6,293 pulls, out of a total of 271 subjects with 51,059 pulls. At this time the reproduction of Cadastral maps had not been commenced, and consequently the printing work of the Lithographic Office was largely in excess of the outturn by Photo-zincography.

Work in 1868-69.

11. Ten years later, in 1878-79, the lithographic work shows a comparatively small increase in subjects and pulls, but, probably owing to the increased use of type for departmental forms, the outturn of the type presses had increased by nearly two thirds. The extra-departmental work amounted to 281 subjects with 89,211 pulls out of 445 subjects with 139,366 pulls, or nearly two thirds of the total work In the Photographic Office, on the other hand, the outturn had increased very largely. In 1876 a special establishment had been sanctioned for the reproduction of the Cadastral maps of the N. W.P., which was commenced in 1875, and in 1878-79 the work was in full activity. The united outturn of the Normal and Cadastral zinc-printing presses, amounting to 5,163 subjects with 218,323 pulls, was more than four times what it was ten years before. The outturn of the Cadastral cameras and presses, though not so large as it was subsequently, amounted to 4,537 sheets with 123,700 pulls. The departmental work had very largely increased and amounted to 465 subjects with 41,570 pulls, exclusive of proofs. The proportion of extra-departmental work, other than Cadastral, had also very largely increased and amounted to 346 subjects with 49,894 pulls out of a total outturn of 811 subjects with 94,623 pulls. At this time heliogravure and photo-collotype had not emerged from the experimental stage.

Work in 1878-79.

12. Advancing another 10 years, to 1888-89, the last year in which the Offices were in the old scattered premises in 1, Camac Street, and 1 and 2, Wood Street, an enormous increase is apparent in the Lithographic and Type Printing Sections, and is due to the employment of machinery; a hand-power lithographic machine having been started in 1884 and a steam type-printing machine in 1885. The outturn of the Lithographic printing presses was nearly 2½ times and of the Type printing presses more than three times as much as it was ten years before. The increase in the Lithographic printing was, however, chiefly in work for other departments, the number of outside subjects printed off being 643 with 278,942 pulls, against only 160 departmental subjects with 64,328 pulls. In the Photographic Office, on the other hand, the departmental work had increased to 799 subjects with 53,397 pulls, and the number of subjects sent in for photography was nearly half as large again as it was ten years before, though the printed outturn of ordinary or "*Normal*" work was somewhat less than one-third more. The amount of extra-departmental work, though not so great as in the Lithographic Office, was considerable, and out of a total of 1,150 subjects with 123,262 pulls, 351 subjects with 69,865 pulls were for other departments. The Cadastral work shows a falling off, due to smaller demands at the time, but it has been increasing since and will be further increased. The outturn of the Silver Printing Section, which was very low in 1878-79, had increased about five times, and has still further increased since and may continue to do so. The heliogravure process, which was for some years in an experimental stage, had by this time been worked out practically and taken its place among the regular processes worked in the Office, and although the photo-collotype process continued to be worked, it was fast giving way to heliogravure and has now been entirely superseded by it. In connection with this section electrotyping had also been introduced and was utilised for the multiplication of engraved copper-plates.

Work in 1888-89.

13. Coming now to last year, 1890-91, the first year in which the new machinery has been working all the year through, and taking it in connection with the two previous years, it will be seen that although the work of the Lithographic Office does not show much increase, the general work of the Photographic Office, and particularly the zinc printing, shows an enormous rise, and the immediate result of the introduction of machinery has been to more than double the outturn of the "*Normal*" Zinc Printing Section since the year 1888-89. Zinc plates are found much handier to manipulate in the machines than stones and the tendency now is to use them in preference to stones whenever it can conveniently be done. In the Lithographic Sections the extra-departmental work had to a very large extent taken the place of departmental work, the proportion of the printed outturn being only 74 departmental subjects with 62,393 pulls, to 643 extra-departmental subjects with 221,426 pulls. The apparent falling off in the printed outturn of the Lithographic Printing Section isdue to the larger use of zinc plates. In the Photographic Office, although the number of extra departmental subjects photo-zincographed had largely increased, it was less than the

Work in 1890-91.

departmental, but the number of pulls in both cases had very largely increased, the proportion being 667 plates of departmental subjects with 111,485 pulls, to 460 plates of extra-departmental subjects with 165,117 pulls. The Cadastral work also shows a very large increase in the two years, due to the larger number of sheets of the Burma and Assam Cadastral Surveys now being printed, and steps are being taken to work up to an outturn of at least 5,000 sheets a year, to complete the maps required for N. W. P. and Assam and meet the increasing demands from Burma.

Increase due to use of steam power.

14. The comparison of the combined outturn of the lithographic and zincographic presses and machines in pulls during the past three years, *viz.*, 466,082, 496,198, and 560,421, respectively, serves to show the increase due to the introduction of steam power in these sections. The increase in the Type Printing Section, though large, is not so marked. It remains to be seen to what extent the work will further increase, but the tendency undoubtedly is steadily in that direction. It must be remembered, however, that the increase of the past three years does not represent the total increase due to the use of machinery alone, because, as noted in paragraph 12 a litho. machine and a type machine had been working since 1884 and 1885. The figures do, however, show the effect of the introduction of steam power, and are exclusive of the Cadastral hand-printed outturn.

Increase of heliogravure work.

15. The returns for 1890-91 and the two preceding years show that the heliogravure work is also steadily increasing year by year. It was hoped that this process would have been more largely utilised for map-work than it has been, but its principal use at present is for the reproduction of shaded drawings and photographs from nature, and it has already almost entirely taken the place of lithography for this purpose. The results, though not perhaps better than really first-class lithography, are very much superior to what can ordinarily be produced here, and the plates are practically everlasting, while stones are very soon worn out. To engrave such plates by hand would tax the resources of the most skilful engravers and cost at least ten times as much. The process undoubtedly permits a comparatively large amount of first class and difficult reproduction to be done very quickly and cheaply. As the demands increase and our means of printing the plates improve, the cost of working the process will be even less than it is now, and there is ample work in hand with the *Technical Art Series* and other subjects to keep the present establishment fully occupied. The new half-tone block processes, now being introduced, will also proved a very effective and even cheaper and quicker means of reproducing many of the subjects that would otherwise have to be lithographed or hand-engraved, and at the present moment we have about 60 drawings in hand to be reproduced by this process for the "*Indian Museum Notes*," besides others. The ease and rapidity with which these new photographic processes of reproduction are now applied tends to cause the immense economy they effect to be lost sight of, while the fact that the processes are more or less automatic and mechanical tends to depreciate their value as compared with hand-work, and to lower the salaries of the skilled photographic assistants as compared with hand-engravers.

Increase of electrotyping.

16. The amount of electrotyping also shows a steady increase during the past three years, and it may be noted that all these valuable new processes of heliogravure, photo-block printing, and electrotyping have been introduced into the Office without any sensible increase to the existing and sanctioned establishments of the Litho. and Photo. Offices, as the post of Photographic Engraver was provided by the abolition of the post of Chief Draftsman in the Lithographic Office. Not only this, but the photo-engraving processes themselves have been worked out and introduced with little expense to Government, whereas other Governments have had to pay heavily for them. Messrs. Meisenbach asked me £2,000 for instruction and materials for working their photo-block process.

Increase of extra-departmental work.

17. I have already drawn attention to the steady increase in extra-departmental work in all the Lithographic and Photographic Sections during the past 20 years. The amount and value of this work will be clearly seen in the accompanying Table B. For some years past the work of the Lithographic Office has been mainly of this character, and although the bulk of the departmental work, which has also very largely increased, falls on the Photographic and Zinc Printing Sections, these latter have also to respond largely to the demands from other departments all over India; and, as a matter of fact, leaving aside the Cadastral maps, the general work of the "*Normal*" Sections of the office is more for other departments than for the Survey, and consequently the consideration of the requirements of the combined Photographic and Lithographic Office should be treated on imperial rather than on merely departmental grounds. It must also be taken into consideration that the demands from other departments are more and more becoming specialised, particularly in the case of lithographic drawing, and, as is the case with work received from the Director-General of Railways, we have to adopt special styles of drawing and printing, and to provide for a large amount of special hand-colouring for engineering plans and drawings, which all have to be executed in the most careful manner and with rigid adherence to patterns which are quite foreign to the style of work in which our draftsmen have been trained. All these various demands have hitherto been cheerfully met and carried out, though in many cases the work has been a heavy tax on our resources. The time has, however, now come when some arrangement must be made either for checking these many and varied extra-departmental demands or for increasing the power of the Office to meet

them. The present continual increase of outturn cannot go on without some corresponding strengthening of the establishment.

Increase in value of work as compared with cost of production.

18. The next point to be considered is the very large increase in the value of the work done as compared with the cost of production: this is seen in the accompanying Table C, which shows the approximate credits and expenditure for the past ten years. It is difficult without a more elaborate system of account than is necessary for the purposes of the Office to accurately ascertain its real financial position, but it will probably be sufficient to compare the cost of production, as represented by pay of establishment, purchase of materials, house-rent and taxes, and contingencies, with the value of the work produced, calculated on the rates now in force. These rates were adopted in 1886, on what was then a fair basis, with the object of covering the total actual cost of the Office without making a profit, so that they ought to represent the cost price of the work with a small margin to cover variations. They were founded on the old and somewhat higher rates which had been in use in the Photographic Office since 1879, and were in 1886 modified to suit the requirements of the Lithographic Office and the Trigonometrical Branch Office at Dehra, and made to apply equally to departmental and extra-depatmental work.

Rates of extra-departmental work.

19. The whole question of rates for extra-departmental work was very carefully gone into in 1879. It was then found that, as a rule, the total cost of photo-zincographic work, including superintendence, materials, and general charges, was about double the actual cost of the labour employed, and an examination of the accompanying table shows that on the whole the cost of establishment is about the same as the combined cost of supervision, materials, house-rent and taxes, and contingencies. Taking the averages of the last eight years it will be found that the average cost of establishment, supervision, house-rent and taxes, and contingencies, amounts to ₹196,173, while the credits by work done and other receipts and credits by sales of waste paper and unserviceable articles, silver-residues, etc., amount to ₹1,97,063, which just covers the expenditure and leaves a small balance of ₹890 to the good. If, however, we take the averages of the past five years during which the new rates have been in operation, we find that while the average expenditure, including the whole cost of the new machinery, amounted to ₹1,96,093, the average of the credits was only ₹1,90,266, or about ₹5,827 less than the expenditure. But if the extraordinary expenditure on machinery, amounting to about ₹25,550 (£1,460 invoice cost), be deducted, then the average yearly expenditure will only be ₹1,70,543, and allowing for interest on the cost of machinery at 4% the credits will exceed the expenditure by about ₹18,700. These calculations have been based on the results of *Survey* years, and the annual value of house-rent for the new buildings has been taken at ₹13,767, as calculated for Municipal purposes at 5% on the total value of the buildings and land, estimated at ₹2,75,341.

B.

Statement of Extra-Departmental Work done in the Photographic and Lithographic Offices during the ten years from 1881-82 to 1891-92.

		Sheets or Subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.								Silver and other Printing.			Heliogravure and Electrotyping.				Photo-collotype.		Value.		
				Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates printed.	Stones.	Pulls.	*Number of Copies.* Colored.	Uncolored.	Total.	Silver Prints.	Blue Prints.	Miscellaneous Prints.	Heliogravure Plates.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	Photo-collotype Plates.	Photo-collotype Prints.	₹	a.	p.
1881-82	Photographic	382	438	...	...	...	...	40,716	...	...	40,223	92	...	...	...	...	...	...	...		16 532	4	4
	Lithographic	346	...	...	...	...	...	129,295	...	...	121,353	...	...	...	...	...	...	...	...	...	20,111	0	10
1882-83	Photographic	566	705	...	...	...	...	53,948	...	...	166,851	141	...	...	...	...	...	...	...	...	22,070	12	0
	Lithographic	471	...	...	...	...	...	117,504	...	...	196,366	...	...	...	...	...	...	...	...	...	22,767	12	5
1883-84	Photographic	371	791	...	...	...	...	58,708	...	...	86,826	261	...	...	...	...	...	...	...	1,933	24,568	6	4
	Lithographic	500	...	...	...	...	...	98,305	...	...	108,146	...	...	...	...	...	...	...	...	...	23,212	11	11
1884-85	Photographic	849	891	871	285	309	...	53,808	...	...	88,968	3,582	...	...	7	2,855	...	...	48	11,374	30,324	8	4
	Lithographic	522	...	...	...	...	433	171,696	16,133	185,637	201,770	...	...	...	...	...	...	...	...	...	24,266	12	0
1885-86	Photographic	626	759	472	208	211	...	55,440	...	...	117,770	5,229	20	48	20	...	1	...	22	4,035	27,749	7	0
	Lithographic	487	...	...	...	...	420	158,309	20,845	134,120	154,965	...	...	...	...	...	...	...	...	...	27,226	7	5
1886-87	Photographic	466	713	701	261	279	...	56,636	...	...	73,478	1,113	10	...	13	229	...	...	18	6,580	22,080	5	0
	Lithographic	517	...	...	...	...	438	143,861	18,015	123,951	141,966	...	...	...	...	...	...	...	...	...	24,416	5	0
1887-88	Photographic	842	972	798	306	323	...	64,127	...	...	91,122	1,556	180	...	55	9,842	...	...	21	4,323	31,035	14	3
	Lithographic	539	...	...	...	...	387	259,322	24,862	254,975	279,837	...	...	...	...	...	...	...	...	...	27,296	5	6
1888-89	Photographic	351	713	698	370	334	...	69,865	...	131,115	131,115	234	49	...	34	19,817	...	3	3	826	27,772	7	10
	Lithographic	643	...	...	...	...	358	278,492	50,863	257,882	308,745	...	...	...	...	...	...	...	...	...	26,780	10	5
1889-90	Photographic	674	1,051	973	562	681	...	154,954	13,770	237,317	251,087	125	178	...	37	28,172	...	...	12	3,372	43,460	10	9
	Lithographic	588	...	...	...	...	420	172,865	59,393	117,219	176,612	...	...	...	...	...	...	...	...	...	26,477	13	3
1890-91	Photographic	946	1,163	1,046	476	460	...	165,117	62,215	157,883	180,098	1,096	288	...	58	31,881	35	...	...	...	37,233	1	0
	Lithographic	600	...	...	...	...	465	221,426	72,265	192,554	264,819	...	...	...	...	...	...	...	...	...	24,711	2	0
	Total	11,286	8,196	5,559	2,468	2,597	2,921	2,524,394	298,361	1,792,653	3,182,117	13,429	725	48	224	92,796	36	3	124	32,443	5,30,093	13	7

Statement showing Credits and Expenditure of the Photographic and Lithographic Offices, Survey of India Department, during the ten years 1881-82 to 1891-92.

	1881-82.		1882-83.		1883-84.		1884-85.		1885-86.		1886-87.		1887-88.		1888-89.		1889-90.		1890-91.		
	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	
Value of Work done.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹		₹	₹	₹	₹	
Lithographic	54,259	...	56,545	...	57,263	...	58,902	...	62,659	...	60,247	...	65,804	...	1,16,976	...	1,39,557	...	2,08,654	...	Average of last 2 years 2,04,514
Photographic, Normal	44,959	...	64,486	...	48,554	...	73,541	...	80,252	...	58,721	...	57,422	...							,, 5 ,, 1,87,319
Photographic, Cadastral	69,836	...	75,266	...	73,358	...	74,525	...	73,616		54,501		61,370	...	52,530	...	60,817	...			,, 8 ,, 1,92,408
TOTAL	1,69,054		1,96,297		1,79,175		2,06,968		2,16,527		1,73,469		1,84,596		1,69,506		2,00,374		2,08,654		
Receipts and Credits by Supply of Stores and Sale of Unserviceable Articles.																					
Lithographic	5,399	...	3,282	...	5,945	...	6,304	...	578	...	254	...	382	...	1,865	...	681	...	827	...	Average of last 2 years ₹ 2,031
Photographic, Normal	...	...	3,947	...	4,720	...	672	...	4,282	...	2,674	...	4,491	...	1,007	...	1,337	...	1,218	...	,, 5 ,, 2,946
Photographic, Cadastral	...	...																			,, 8 ,, 4,654
TOTAL	5,399		7,229		10,665		6,976		4,860		2,925		4,873		2,872	...	2,018		2,045		
Cost of Establishment.																					
Lithographic	...	29,919	...	30,370	...	34,319	...	35,197	...	33,575	...	33,925	...	34,236	...	34,547	...	34,218	...	34,437	
Photographic, Normal	...	19,676	...	24,222	...	28,320	...	27,367	...	32,150	...	30,961	...	31,843	...	30,266	...	29,748	...	31,963	
Photographic, Cadastral	...	19,304	...	24,704	...	33,859	...	28,881	...	33,057	...	29,820	...	34,257	...	33,858	...	30,622	...	30,036	
TOTAL		68,899		79,296		96,498		91,445		98,782		94,706		1,00,336		98,671		94,588		96,436	Average of last 2 years ₹ 95,511
Cost of Supervision.																					,, 5 ,, 96,947
Lithographic	...	...	...	...	...	5,200	...	6,000	...	7,444	...	7,659	...	8,116	...	8,014	...	6,910	...	5,536	,, 8 ,, 96,432
Photographic, Normal	...	6,789	...	6,275	...	5,200	...	6,376	...	7,444	...	7,659	...	8,116	...	8,014	...	6,910	...	5,536	
Photographic, Cadastral	...	6,789	...	6,275	...	5,200	...	6,376	...	7,444	...	7,659	...	8,116	...	8,014	...	6,910	...	5,536	
TOTAL		...		...		15,600		18,752		22,332		22,977		24,348		24,042		20,730		16,608	Average of last 2 years ₹ 18,669
Cost of Materials.																					,, 5 ,, 21,741
Lithographic	...	9,422	...	7,019	...	8,823	...	21,372	...	19,623	...	13,622	...	24,118	...	65,483	...	52,535	...	37,461	,, 8 ,, 20,673
Photographic, Normal	...	28,084	...	24,819	...	38,261	...	23,788	...	68,186	...	56,848	...	24,349	...						
Photographic, Cadastral	...																				Average of last 2 years ₹ 44,998
TOTAL		37,506		31,838		47,084		45,160		87,809		69,370		48,467		65,483		52,535		37,461	,, 5 ,, 54,763
House-rent and Taxes.																					,, 8 ,, 56,733
Lithographic	...	3,841	...	3,841	...	3,781	...	3,841	...	3,860	...	3,879	...	3,894	...	3,542		29		* 1,342	
Photographic, Normal	...	4,483	...	4,479	...	4,481	...	4,402	...	4,503	...	4,525	...	4,542	...	4,884	...	50	...	* 2,013	
Photographic, Cadastral	...	...	...	185	...	2,769	...	3,295	...	3,351	...	3,426	...	3,439	...	2,731	...	...	...	* 2,013	
TOTAL		8,324		8,505		11,031		11,538		11,714		11,830		11,875		†3,442	...	†13,767	...	†13,767	Average of last 2 years ₹ 16,490
Contingencies.																14,599		13,846		19,135	,, 5 ,, 14,257
Lithographic	...	818	...	1,014	...	1,266	...	1,363	...	1,323	...	1,141	...	1,547	...	2,376	...	2,470	...	1,545	,, 8 ,, 13,196
Photographic, Normal	...	1,628	...	1,282	...	1,977	...	1,909	...	2,587	...	2,122	...	1,594	...	1,420	...	2,570	...	1,677	
Photographic, Cadastral	...	6,391	...	5,195	...	7,69	...	5,653	...	7,400	...	7,455	...	4,211	...	3,177	...	4,234	...	4,387	
TOTAL		8,837		7,491		10,939		8,925		11,310		10,718		7,352		6,973		9,274		7,609	Average of last 2 years ₹ 8,441
GRAND TOTAL	...	...	...	...	1,89,840	1,81,152	2,13,944	1,75,820	2,21,387	2,31,947	1,76,394	2,10,191	1,89,469	1,92,378	1,72,378	2,09,767	2,02,392	1,90,973	2,10,699	1,77,249	,, 5 ,, 8,385
PROFIT OR LOSS	...	...	...	...	*+8,688*	...	*+38,124*	...	*—10,560*	...	*—33,707*	...	*—2,909*		*—37,389*		*+11,419*		*+33,450*		,, 8 ,, 9,237

* Including arrears of taxes, ₹1,342 for Lithographic, and ₹671 each for Photographic Normal and Cadastral.

† Annual Value of house-rent in new buildings taken, on the Municipal valuation, at ₹13,767. Only 3 months charged in 1888-89.

30. From table C it will be seen that the value of the outturn has increased very largely during the past two years, during which the Offices have been in the new building and the steam machinery has been at work; the difference between the value of the work done in 1888-89 and that done in 1889-90 being over ₹30,000, and last year it was over ₹38,000, and this notwithstanding that the rates for machine printing have been reduced to ¼ the ordinary rates for hand-printing in cases when the number of copies is over 1,000, and to ½ rates when below that number. Moreover, there has not only been a large increase in the value of work done, but a considerable decrease in the cost of working the Office. In 1888-89 the total cost of the Offices was ₹2,09,767; in 1889-90 it decreased to ₹1,90,973; and in 1890-91 to ₹1,77,249. Putting the last two years together, the total average credits are ₹2,06,545, while the average expenditure is only ₹1,84,111, showing an average balance in favour of the Department for each year of ₹24,434. There has also been a reduction in the total cost of establishment from ₹1,00,336 in 1887-88 to ₹96,436 in 1890-91. It should be noted that ₹9,891 have been included in the expenditure on account of cost of machinery, and that house-rent and taxes for the new building show a large increase over former years.

Increase in value of outturn and reduced expenditure.

31. It will be seen, therefore, that the immediate effect of the removal of the Offices into the new building and the introduction of machinery has been a very great economy in the working of the Office, shown by largely increased outturn and reduction of expenditure. The cost of the machinery has already been nearly repaid twice over.

Economy of new Offices and machinery.

32. The reduction of expenditure on establishment is due to a variety of causes, but chiefly to savings in the Photographic Office caused by two posts of photographers on ₹300+30 H. R. not being filled up, and one on ₹180+20 H. R. being filled temporarily by an assistant photographer. As I intended to absorb these three posts in the re-organisation, I was unwilling to fill them up, even temporarily, and in the meantime the work was done by apprentices on ₹40 and other underpaid assistants. This arrangement, which was, however, only made with the prospect of a very early re-organisation of the Office, has already continued for longer than was originally contemplated, and it certainly cannot continue as a permanency in justice to the men employed. Had I known that the re-organisation would have been so much delayed, I should have made a special application for the absorption and utilisation of these posts. One post of zincographer on ₹300+30 H. R. was filled up in 1890 on the minimum salary of ₹125+20 H. R. Supervision has also been cheaper, only one Officer having been employed since the Offices came into the new building. It was expected that some reduction might have been effected in the number of litho. and zinc printers by the substitution of machine for hand labour, but, owing to the increased demands on the Office for printing work, there has been constant work for both machines and hand presses, and only three hand presses have been reduced.

33. It may be remarked that, had the new buildings and machinery not been provided, the expenditure instead of being lessened must have been largely increased. We should either have had to refuse much of the outside work or we must have largely increased our hand presses and printing establishment, and would have required a fourth house and another Officer to assist in the supervision of these scattered Offices; one Officer alone could not have done it.

34. There can, I think, therefore, be no doubt that the new building and machinery have been a very great advantage and economy to the State, and the addition of a second large lithographic machine and the small additional establishment I am now asking for will, I feel convinced, also be well repaid by increased outturn, and the additional expenditure will be well justified.

35. In face of this large increase in the credits of the Office, it becomes a question whether the rates should be reduced to cheapen the work still further. I do not, however, think it desirable to do so generally at present. First, because we shall have to meet the increased expenditure now proposed, and it is well to have a sensible margin of profit in order to meet any further increased expenditure that may be necessary. Secondly, because the rates, as now fixed, are moderate, and the Government certainly could not get the work done for less elsewhere. There is nothing like a standard market rate in India for most of the work we do, but from such indications as we are now and then able to obtain, it would appear that our rates, though in some cases high, are not excessive, even when compared with home rates. Photographic work is cheaper as compared with the rates charged by local photographers. For instance, one firm of Calcutta photographers charges ₹35 for an 18 × 16 dry-plate negative, whereas our charge would not be more than ₹10, the rate for wet-plate negatives being only ₹5-8. Our prices for silver printing are much less than shop prices, especially for the larger sizes. On a recent reference about some illustrations for Dr. Alcock's Report on the Fishes of the Bay of Bengal, it was found that the original drawings could be reproduced in good style by the heliogravure process for very much less than they would have cost to lithograph in England. Our rates for lithographic printing, done in comparatively small numbers, cannot well be compared with rates in Europe, where skilled labour for drawing and printing is plentiful and work is turned out in very much larger numbers. But it may very safely be asserted that the photographic and printing work we do could not be done for Government so conveniently or so cheaply in any other way, though I am aware that it is possible to obtain lithographic drawing cheaply done by ex-students of the School of Art. No large private lithographic printing office has ever been able to carry on work in Calcutta.

Present decrease of rates undesirable.

26. I find that our rates for heliogravure printing are not much higher than home rates, especially for larger sizes. For royal 4to (12 × 10) Messrs. Annan and Swan's rates are 17*s.* 6*d.* (say ₹13-8) per 100, including paper, and for royal 8vo 14*s.* per 100 (say ₹11): our charges for the same sizes would be ₹12 and ₹10 per 100, exclusive of paper and percentage. For larger-sized work we should be much cheaper than the home rates, and as a matter of fact we supply the plates of the *Technical Art Series* (4to imperial, 15 × 11) at 2 annas each, or ₹12-8 for 100, including all charges for plates, negatives, and paper. Most of our work is, however, small or medium sized.

Rates for Heliogravure.

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

Statement showing the work performed during the year 1892-93.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
ATLAS OF INDIA.			
Sheets Nos. 14, 24, 35, 43, 44, 47, 48, 54, 60, 61, 62, 67, 68, 74, 75, 80, 89, 102, 103, 104, 105, 106, 107, 111, 112, 113, 114, 115, 116, 118, 119, 120, 125, 2S.E., 6N.E., 10S.W., 14N.E., 15N.W., 15S.W., 38S.W., 48S.E., 49N.W., 49S.E., 50N.E., 67N.W., 67N.E., 67S.E., 67S.W., 72N.E., 72S.E., 87N.E. 91N.W., 91S.W., 124S.W., 126S.E., 127N E.,and 127S.E. . .	1=4	57	Additions made to railways, roads, canals, and changes to boundaries.
Sheets Nos. 11N.W., 11S.W., 16N.E., 21N.W, 23N.E., 24N.E., 24S.E, 30N. E, 30S.E., 31N.E., 31N.W., 36S.W., 37N.W., 37S.W., 40S.E., 59N.W., and 102 S.W.	1=4	17	Additions made to names and detail for engraving.
Sheets Nos. 145N.W. and 145S.W.	1=4	2	Ditto ditto in progress.
Sheets Nos. 12N.E., 21N.E., 21S.E., 36N.W., 40N.W., and 40S.W., . . .	1=4	6	Hills brush-shaded for engraving.
GENERAL MAPS.			
India (lithographed) . .	1=32	6	3rd edition; in progress.
Do. do. (without hills)	1=32	6	Railways inserted to March 1893.
Do. do. (railways) . .	1=48	4	Ditto ditto.
Do. do. (do). .	1=128	1	Ditto ditto.
Do. do. (skeleton) .	1=64	2	Insertion of district names and boundaries.
Do. (engraved) (without hills)	1=32	6	Additions to date.
Do. (do.) . . .	1=64	4	Additions to railways to March 1893.
Indo-China	1=32	4	A new compilation; completed.
PROVINCIAL MAPS.			
Upper Burma	1=16	2	A new compilation; completed.
Mysore (engraved) . .	1=16	1	Hills brush-shaded for engraving; in progress.
Do. do. . .	1=16	1	Addition of Coorg and railways to August 1893.
North-Western-Provinces and Oudh (engraved) . .	1=16	2	Additions to railways made.
Rajputana Agency (engraved) .	1=16	2	Ditto ditto.
Gujarat do. .	1=16	1	Additions and corrections made to date.
Bombay	1=16	1	A new compilation; for engraving; in progress.
Madras.	1=16	5	Ditto ditto one sheet only in progress.
Bengal, Bihar, Orissa and Chota Nagpur	1=16	2	Additions made to October 1892.
Central India Agency . .	1=16	2	Ditto ditto.
Bengal	1=16	2	Addition and corrections made to boundaries to December 1892.
Assam	1=16	1	Additions and corrections made to May 1893.
Punjab	1=16	4	Additions made to railways to March 1893.
DIVISIONAL MAPS.			
Orissa	1=4	4	Additions made to canals to April 1893.
Chota Nagpur . . .	1=4	4	A new compilation; in progress.
Presidency	1=4	4	Additions and corrections made to date.
Agra	1=4	2	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

Title.	Scale.	Number of Sheets.	Remarks.
DISTRICT MAPS.	In. M.		
Bannu	1=4	13	Additions and corrections made to 1892.
Bhagalpur			
Birbhum			
Champaran			
Goalpara			
Khulna			
Midnapur			
Muzaffarpur			
Naga Hills			
Pabna			
Patna			
Rangpur			
Sonthal Parganas			
Balasore	1=4	...	Additions and corrections made to 1893.
Burdwan			
Chittagong			
Cuttack	1=4	14	Additions and corrections made to 1893.
Faridpur			
Hazaribagh			
Hooghly			
Howrah			
Jessore			
Manbhum			
Rajshahi			
Sylhet			
Tippera			
24-Parganas			
STANDARD MAPS.			
ASSAM—			
Sheets No. 3	1=1	1	Additions made to railways.
BENGAL—			
Sheets Nos. 96 and 98	1=1	2	Additions made to canals.
BOMBAY—			
Sheets Nos. 56, 57, 65, 66, 161, 162, 181, 184 and 215	1=1	9	Additions made to roads and railways.
CENTRAL PROVINCES—			
Sheets Nos. 5, 8, 9, 13, 14, 15, 16, 17, 19, 20, 21, 22 and 27	1=1	14	Additions made to roads, railways, and canals.
MADRAS—			
Sheets Nos. 137, 138, 150, and 152	1=1	4	Additions made to roads, railways, and canals in progress.
NORTH-WESTERN PROVINCES AND OUDH—			
Sheets Nos. 2, 3, 4, 30, 31, 32, 33, 34, 35, 36, 37, 49, 51, 52, 53, 99, 116 and 144	1=1	18	Additions made to roads, railways, and canals.
PUNJAB—			
Sheets Nos. 1, 2, 3, 4, 5, 6, 7, 9, 13, 14, 17 and 21	1=1	12	Additions made to roads and canals.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS —*continued.*	In. M.		
LOWER BURMA—			
Sheets Nos. 226, 231, 232	1=1	3	Additions made to roads and railways.
Sheets Nos. 273, $\frac{N.E.}{3}$, and 273 $\frac{S.E.}{1,3}$	1=4	2	Additions made to hills.
UPPER BURMA (NORTH-EAST FRONTIER SERIES)—			
Sheets Nos. 15N. W. and 15S. W.	1=4	2	Compilation in progress.
Sheet No. 22N. W. (3rd edition)	1=4	1	Ditto
Sheet No. 15 (2nd edittion)	1=8	1	Completed.
Sheet No. 15 (3rd edition)	1=8	1	Ditto.
Sheet No. 22 (4th edition)	1=8	1	Ditto.
Sheet No. 22 (5th edition)	1=8	1	In progress.
Sheet No. 23 (3rd edition)	1=8	1	Ditto.
UPPER BURMA (SOUTH-EAST FRONTIER SERIES)—			
Sheets Nos. 1N. W. and 1S. W. (3rd edition)	1=4	2	Completed.
Sheets Nos. 2N. W. and 2S. W. (3rd edition)	1=4	2	In progress.
Sheet No. 1 (4th edition)	1=8	1	Ditto
Sheet No. 3 (2nd edition)	1=8	1	Completed.
Sheet No. 4 (2nd edition)	1=8	1	In progress.
Sheet No. 5 (1st edition)	1=8	1	Ditto.
Sheet No. 6 (2nd edition)	1=8	1	Ditto.
Sheet No. 7 (2nd edition)	1=8	1	Completed.
ADMINISTRATION REPORT MAPS.			
ASSAM—			
Cachar Goalpara Sylhet	1=8	3	Corrected to 1893.
CENTRAL PROVINCES—			
Balaghat Bhandara Bilaspur Chhindwara Damoh Jubbulpore Mandla Nagpur Nimar Narsinghpur Raipur Saugor Seoni Wardha	1=8	14	Corrected to 1893.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ADMINISTRATION REPORT MAPS—contd.	In. M.		
HYDERABAD.			
Akola, Amraoti, Basim, Buldana, Ellichpur, Wun	1=8	6	Corrected to 1893.
NORTH-WESTERN PROVINCES.			
Agra, Bareilly, Cawnpore, Farakhabad, Unao	1=8	5	Ditto.
PUNJAB.			
Ferozepore, Gurdaspur, Hazara, Simla, Shahpur	1=8	5	Ditto.
INDEX MAPS.			
To illustrate progress of Field Parties	Various	13	Corrected to September 1893.
MISCELLANEOUS MAPS.			
Road from Peyzu to Dera Ismail Khan, North-Western Frontier	1=1	1	A tracing prepared.
Index Map of Rushi Kalya Project	1=1	1	Ditto
Index Map of Etawah Division	1=1	1	Ditto.
Map of Arracan Frontier	1=3	1	Ditto.
Charts of Tidal curves	...	21	Prepared for lithography
Aden and surrounding country	1=4	1	Drawn and completed.
WORK DONE FOR OTHER DEPARTMENTS.			
STATISTICAL MAPS.			
India illustrating Physical Configuration	1=32	9	One set prepared for the Imperial Institute, London, and another set for the Antwerp Exhibition, in progress.
Do. do. Geology			
Do. do. River basins			
Do. do. Density of population			
Do. do. Rainfall			
Do. do. Railway coal and iron			
Do. do. British Provinces and Native States			
Do. do. Religion			
ADMINISTRATION REPORT MAPS.			
Bengal Police	1=80	4	Showing different crimes.
Do. Mortality	1=80	4	Showing fatal fever, cholera, and small-pox during 1892.
Do. Revenue	1=80	6	Showing sources of excise revenue.
Do. Education	1=80	3	Showing different kinds of education.
Do. Rainfall	1=80	1	Showing distribution of rainfall.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
ADMINISTRATION REPORT MAPS—contd.			
Bengal Population	1=80	4	Showing (1) density of population, (2) variation of population between 1881 and 1891, (3) proportion of Hindu population, (4) proportion of Mahomedan population.
Do. Traffic	1=80	1	Showing railways, canals, and canalized rivers, corrected to date.
India Emigration	1=256	1	Showing Inland emigration, 1892.
Do do.	1=96	1	Showing Colonial emigration, 1892.
Central Provinces	1=80	1	Showing limits of Districts, Feudatory States, Tahsil and Forest boundaries in progress.
Do. do.	1=16	2	Tahsil boundaries inserted on three printed copies for the Deputy Commissioner of Balaghat.
Extract from sheets Nos. 14 N.E., and 14 S.E, and 22 N.W, and 22 S.W., North-Eastern Frontier Series	1=4	2	Prepared for F. J. Needham, Esq, Assistant Political Officer, Sadiya.
Kashmir and parts of Afghanistan; Districts Ajmere and Merwara; Siam and adjacent countries; Persia and Afghanistan	1=32	5	Prepared for Aitchison's Treaties and completed.
East Coast of Africa	1=25	1	Ditto ditto.
MAPS, COLOURED.			
Maps on various scales	...	588	For Surveyor-General's Office.
Ditto ditto	...	711	For other Departments.

DESCRIPTION OF WORK.	Number of Sheets.
Maps examined.	
Atlas sheets	59
General maps	26
Provincial maps	35
Divisional map	1
District maps	21
Standard maps	19
Administration Report maps	45
Index maps	16
Statistical and special maps	378
Triangulation charts	2
Miscellaneous maps (departmental)	105
Ditto (extra-departmental)	20
Office copies of various maps, with additions and corrections in territorial boundaries and public works	236
Engraved proofs of atlas sheets in various stages	79
Engraved proofs of general and provincial maps, including index charts	73
Engraved proofs of district maps	56
Litho. proofs of general and provincial maps, including index charts	44
Litho. proofs of district maps transferred from copper-plates	12
Photo. proofs of standard maps, large-scale plans, and various other maps	342
Colouring of maps for various purposes	462
Tracings of maps for various purposes	12
Projection and examination of graticules and plotting of points	53
TOTAL	2,102

N.B.—In addition to the above, many miscellaneous jobs, such as supply of geographical data to various officials, calculation of areas, computation of latitudes, longitudes, azimuths, etc., and of graticules for the projection of the sheets of the Indian Atlas, compilation of the catalogue of maps and charts of Burma, examination of the proof sheets of the "Survey of India Notes," as to the correct orthography of geographical names, etc., have been performed by the Examining Section.

DRAWING OFFICE, CALCUTTA.

SECTION II—REVENUE.

Statement showing the work performed during the year 1892-93.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS.	In. M.		
PUNJAB.			
Districts Ferozepore, Hissar and Karnal, and Patiala State.			
Sheets Nos. 227, 241, 271, 272, 273, and 274	1=1	6	Proofs passed; press order given.
Sheets Nos. 213 and 214	1=1	2	Roads and canals inserted.
Sheet No. 228	2=1	4	Fair maps corrected.
Sheets Nos. 253 and 254	1=1	2	Boundaries inserted on fair maps.
District Hazara.			
Sheets Nos. 1, 2, 5, 10 and 14	1=1	5	Proofs passed; press order given, to meet the requirement of officer commanding Punjab Frontier Force.
District Peshawar.			
Sheets Nos. 5 and 6	1=1	2	Proofs passed; press order given.
District Delhi.			
Sheets Nos. 53, 54, and 60	1=1	3	Ditto ditto.
District Dera Ghazi Khan and Bahawalpur State.			
Sheets Nos. 6 and 33	2=1	3	Fair maps corrected from new materials.
NORTH-WESTERN PROVINCES AND OUDH.			
Districts Naini Tal (including portions of the late Tarai and Kumaun Districts), Bijnor and Moradabad.			
Sheets Nos. 46, 63, 250, 251, 81 and 97	1=1	6	Proofs examined and sent to press.
Sheets Nos. 64 and 65	2=1	8	Examined, corrected, and held in abeyance for incorporation with recent survey of Rampur State.
Districts Bareilly and Pilibhit.			
Sheets Nos. 81, 82, 83, 97 and 98	1=1	5	Examined, held in abeyance, pending return of proofs from local officials.
Districts Meerut, Moradabad and Bulandshahr.			
Sheet No. 32	2=1	4	Fair maps corrected and completed to margin sent to press.
Sheet No. 33	1=1	1	Proof passed; press order given.
District Kheri.			
Sheet No. 98	1=1	1	Additions and corrections made to boundaries.
Districts Hardoi, Unao and Lucknow.			
Sheets Nos. 105, 106 and 120	1=1	3	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
Districts Gonda and Fyzabad.			
Sheets Nos. 160 and 161	1=1	2	Proofs passed; press order given.
Sheets Nos. 160, 161 and 162	1=1	3	Additions and corrections made to boundaries.
District Ballia.			
Sheet No. 219	1=1	1	Additions and corrections made to boundaries.
Portion of the Naini Tal (late Kumaun) District.			
Sheets No. 46 $\frac{N.E.}{2,4}$, $\frac{S.E.}{2}$; No. 63 $\frac{N.W.}{1,3,4,}$, $\frac{N.E.}{3}$, $\frac{S.W.}{1,2,3,4,}$ $\frac{S.E.}{1,3,4,}$; No. 64 $\frac{N.E.}{1,2,3,4,}$ $\frac{S.E.}{2}$; No. 250 $\frac{S.W.}{3}$; and No. 251 $\frac{N.W.}{1,2,3,4,}$, $\frac{S.W.}{1,2,3,4,}$, $\frac{S.E.}{1,3}$	4=1	30	Publication deferred; awaiting further instructions.
District Jhansi.			
Sheets Nos. 40 and 78	1=1	2	Fair maps examined and press order given.
Sheets Nos. 39A, 41, 56A, 57, 58, 59, 77, 79 and 80	1=1	9	Fair maps examined; first proofs received and returned for correction.
BENGAL.			
Angul Estate (Orissa).			
Sheets Nos. 104, 105, 132, 133, and 134	1=1	5	Proofs passed; press order given.
Sheets Nos. 104S. E.; 105N. E and S. E., and 134N. W. and S. W.	2=1	5	Fair maps corrected to meet the requirement of Forest Department; press order given.
District Cuttack.			
Killa Kujang.			
Sheets Nos. 223, 224, 195 and 196	1=1	4	Proofs examined and held in abeyance for return of same from local officials.
Killa Kanika.			
Sheets Nos. 221, 222, 247 and 248	1=1	4	Fair maps corrected; proofs examined and sent to press.
District Darjeeling (including British Sikkim, by Captain Harman).			
Sheets Nos. 269, 270 and 292	1=1	3	Proofs examined and held in abeyance pending return of same from local officials.
Districts Darjeeling, Jalpaiguri and Purnea.			
Sheets Nos. 271 and 293	1=1	2	Proofs examined and held in abeyance pending return of some from local officials.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
District Hazaribagh.			
Sheets Nos. 118, 121, 122, 148, 149, 150, 180, and 181	1=1	8	Fair maps corrected; press order given.
Sheet No. 207	1=1	1	Being completed to margin, in progress.
District Jalpaiguri.			
Forest Survey.			
Sheets No. 293 $\frac{N.E.}{2,3,4}$ $\frac{S.E.}{1,2,3,4.}$ $\frac{S.W.}{2,4}$; No. 294 $\frac{N.W.}{2,4}$, $\frac{N.E.}{1,2}$; No. 315 $\frac{N.W.}{3}$, $\frac{S.W.}{1,2,3}$, $\frac{S.E.}{1,2,3,4}$; No. 316 $\frac{N.W.}{1,2,3,4}$, $\frac{N.E.}{1,2,3,4}$, $\frac{S.E.}{2,3,4.}$; No. 337 $\frac{S.W.}{3}$; and No. 338 $\frac{N.W.}{1,2,3,4}$, $\frac{S.W.}{1,2,3}$, $\frac{N.E.}{1,2,3,4}$, $\frac{S.E.}{1,2,3,4}$	4=1	48	Fair maps corrected and sent to press. Proofs in progress
District Mymensingh.			
Sheet No. 361	1=1	1	Proofs passed; press order given.
District Lohardaga.			
Sheets Nos. 1 to 11	1=1	11	Additions and corrections made to boundaries.
District Palamau (new district formed from a portion of Lohardaga).			
Sheets Nos. 1 to 16	1=1	16	Ditto ditto.
ASSAM.			
District Lakhimpur.			
Sheets Nos. 97, 98, 113, 114, 128, 129, 130, 139, 140, 144, 145 and 146	1=1	12	Proofs passed; press order given.
Sheets Nos. 84, 85, 99, 100, 115 and 131	2=1	12	Fair maps corrected and being completed to margin.
District Sibsagar.			
Sheets No. 99, 100, 115 and 131	2=1	16	Projected and reduced by pentagraph from 4-inch to 2-inch scale. In progress.
CENTRAL PROVINCES.			
District Chanda.			
Sheet No. 13	1=1	1	Proofs passed; press order given.
BOMBAY.			
Sheets Nos. 154, 186, 188, 274, 304 and 330	1=1	6	Ditto ditto.
Sheets Nos. 158, 159, 160, 183, 240, 272 and 273	2=1	28	Fair maps corrected and sent to press.
Sheets Nos. 57 and 85	1=1	2	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

Title.	Scale.	Number of Sheets.	Remarks.
STANDARD MAPS—*contd.*	In. M.		
BOMBAY—contd.			
Sheet No. 9 north (half degree sheet) Jodhpore and Palanpur States :—			
Includes Ran and country bordering on it	1=2	1	Fair maps corrected and sent to press.
Sheets Nos. 59, 66, 67, 173, 203, 270, 275 276, 305, 333, 338, 339 and 353	1=1	13	Additions and corrections made to boundaries.
LOWER BURMA.			
Sheets Nos. 143, 185, 186, 187, 188 and 233	1=1	6	Proofs passed ; press order given for 2nd edition.
Sheets Nos. 144, 189 and 190	1=1	3	Proofs passed ; press order given.
Sheets Nos. 232, 234, 235, and 236	2=1	16	Fair maps corrected and sent to press.
Sheet No. 237	2=1	4	Fair maps examined ; corrections in hand.
UPPER BURMA.			
District Kyaukse.			
Sheets Nos. 261, 262, 263 and 264	2=1	12	Fair maps corrected and sent to press.
District Mandalay.			
Sheets Nos. 258, 259, 260 and 261	2=1	13	Fair maps ; corrections in hand.
PARGANA MAPS.			
BENGAL.			
District Backergunge.			
Sheet No. 1	1=1	1	Printed map touched up for reproduction by photography ; press order given.
Sheets Nos. 1 to 10	1=1	10	Additions and corrections made to boundaries.
District Manbhum.			
Main Circuit Nos. 1 to 15	1=1	15	Ditto ditto.
District Murshedabad.			
Sheets Nos. 1 to 13	1=1	13	Ditto ditto.
District Mymensingh.			
Sheet No. 20	1=1	1	Printed map touched up for reproduction by photography ; press order given.
Sheets Nos. 1 to 26	1=1	26	Additions and corrections made to boundaries.
District Noakhali.			
Main Circuit Nos. 2, (3, 4, 5) and (10, 11, 12, 13)	1=1	3	Printed maps touched up for reproduction by photography ; press order given.
District Patna.			
Sheets Nos. 1, 2, 3, 5 and 6	1=1	5	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Scale.	REMARKS.
PARGANA MAPS—*contd.*	In. M.		
BENGAL—contd.			
District Rajshahi.			
Main Circuit Nos. 6, 11, 12, 14, 15 and 16	1=1	6	Printed maps touched up for reproduction by photography; press order given.
Districts Saran and Champaran.			
Sheets Nos. 2, 3, 4, 5, 6, 7, 8, 13, 14, 17, 18, 20, 21, 22, 24, 25, 26, 27 and 28 . . .	1=1	19	Ditto ditto.
District Shahabad.			
Sheets Nos. 1 and 2 . .	1=1	2	Additions and corrections made in boundaries.
District Tippera.			
Main Circuit Nos. (1, 2, 3, 4, 6), 5, 7, 8, 9, 10, 11, and 12 .	1=1	8	Printed maps touched up for reproduction by photography; press order given.
CENTRAL PROVINCES.			
District Raipur.			
Sheets Nos. 9 to 16 . . .	1=1	8	Additions and corrections made to boundaries.
District Seoni.			
Sheets Nos. 1 to 10 . .	1=1	10	Printed maps touched up for reproduction by photography; press order given.
DISTRICT MAPS.			
Bengal.			
Backergunge	1=4	1	Additions and corrections made to boundaries.
Lohardaga	1=4	1	Ditto ditto.
Midnapur	1=4	1	Fair map corrected.
Murshedabad	1=4	1	Additions and corrections made to boundaries.
Mymensingh	1=4	1	Ditto ditto.
Palamau	1=4	1	Ditto ditto.
Rangpur	1=4	1	Ditto ditto.
Central Provinces.			
Nagpur and Wardha . .	1=2	4	Printed maps touched up for reproduction by photography.
Raipur	1=2	6	Proof passed; press order given.
North-Western Provinces and Oudh.			
Almora	1=2	4	Drawing in progress.
Garhwal	1=2	4	Ditto ditto.
Gorakhpur	1=2	4	Proofs examined, and await return of same from local officials.
Mirzapur	1=2	4	Drawn and sent to press.
Punjab.			
Gujranwala	1=2	2	Printed maps touched up for reproduction by photography.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PLANS OF CITIES AND CANTONMENTS.	In. M.		
Cawnpore Cantonment	12=1	4	Originals corrected; press order given.
City of Calcutta	3=1	1	Proofs passed; press order given.
Delhi Cantonment and City	6=1	4	Originals corrected; press order given.
Fyzabad City	6=1	1	Additions and corrections made in original.
Kolhapur City	8=1	1	Fair map corrected and sent to press.
Lucknow City	6=1	1	Additions and corrections made in original.
Mandalay City	1=1	1	Prepared from fair sheets; proofs under examination.
MISCELLANEOUS.			
Bhutan-Jalpaiguri boundary	1=1	3	Inserted on two sets of printed sheets.
Nepal boundary along Sarda River	2=1	4	Projected, plotted and drawn; proofs under examination.
Manipur-Thaungdut boundary	4=1	1	Fair map corrected and press order given.
Lansdowne Forest	4=1	2	Drawing in progress.
Kadana State	2=1	2	Fair maps prepared; proofs passed; press order given.
Extension of Calcutta round Panchanagram	4=1	9	Plotted and compiled from separate village plans.
Central Provinces for Census Report	1=32	1	Drawn and examined; proofs passed; press order given.
Mandalay, including country within a radius of ten miles of city	1=1	2	Prepared from fair maps for Deputy Assistant Quarter Master General; proofs under examination.
Manœuvre map of Rawalpindi	1=1	2	Prepared for Deputy Assistant Adjutant General; proofs examined and sent to press.
Maliwun Township (Tin Mine)	8=1	1	Fair map corrected; proofs passed; press order given.
INDEX MAPS.			
Jhansi showing Forest Reserves	...	1	Fair map corrected; proofs examined and sent to press.
For Administration Report	...	9	Drawn and sent to press.
Ditto ditto	...	19	Corrected to 1893 and sent to press.
Tracings prepared.			
Tracings of sheets	...	47	
Village plans	...	47	
Maps coloured.			
Maps on various scales	...	138	For Surveyor-General's Office.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

Statement of work—continued.

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Lalitpur, Seasons 1888—90.	
District Nagpur, „ 1887—89.	
Angul Government Estate, „ 1886—88.	
Nepal-Pilibhit Boundary, „ 1892—93.	
Traverse data, etc., supplied.	
District Gorakhpur along district Saran	For Nos. 4 and 5 Party.
District Tippera along taluka Roshnabad	For No. 2 Party.
District Tippera, pargana Serail	For ditto.
District Sialkot along Jummoo territory	For Deputy Commissioner.
Bhawalpur State along Sind	For Indus river detachment.
District Akyab along unsurveyed portion	For Mr. J. C. Clancey.
Rohilkhand along Nepal (Captain Anderson's survey)	For Mr. G. D. Cusson.
Village traverses supplied, 97 pages	To public officers.
Triangulation data of points on the boundary between district Sylhet and Tippera Hills	For Deputy Commissioner.
Field book of Sialkot and Jummoo boundary	For ditto do.
Values and description of level bench-marks in and around Prome	For Superintending Engineer.
Miscellaneous.	
Calculated spherical co-ordinates of Revenue Survey points on the boundary between Nepal and Rohilkhand; also of the points of origin of districts Goalpara, Kheri, Gonda and of certain pillars on the Bhutan Boundary, each from several Great Trigonometical Stations; prepared three traverse circuits of three groups of villages of districts Malda, Pubna and Nuddea, and plotted the same on 4-inch scale for congregated village maps; prepared seven traverse circuits for grouping the villages on the south and east of Calcutta, and plotted them on 4-inch scale for incorporation with and extension of the Calcutta map for Government of Bengal; prepared a statement showing the different local measures in use in district Muzaffarpur; re-set up traverses of certain villages of pargana Chakye for settling the discrepancy in the boundary between districts Monghyr and Sonthal parganas; revised the area of district Shahpur; prepared a report on the permanent village triple junction marks of Bombay since the commencement of survey operations in 1870-71; prepared eight tables for converting acres into bighas, cottahs and dhoors, and *vice versâ*; calculated rectangular co-ordinates from the origin of survey of pillars of forest tracts in districts Kheri and Gonda for Superintendent, Forest Surveys; calculated areas by *parganas* of 13 sheets Assam, 9 sheets Bengal and 16 sheets North-Western Provinces; calculated the areas of all districts and Native States in North-Western Provinces and Oudh for Chief Secretary, North-Western Provinces Government; examined 16 tables for converting acres into the different local measures in use in Orissa.	

DRAWING OFFICE, CALCUTTA.

SECTION III.—CADASTRAL.

State of publication of Cadastral Maps on the 30th September 1893.

DISTRICTS.	NUMBER OF SHEETS. MAPS PREPARED. Up to 30th September 1892.	Added during past 12 months.	Total up to 30th September 1893.	PUBLISHED. Up to 30th September 1892.	During past 12 months.	Total to 30th September 1893.	Remaining to be published.	REMARKS.
North-Western Provinces.								
Agra	2,942	...	2,942	2,942	...	2,942	...	(a) Figures of previous return have been changed to agree with final results.
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,601 (a)	...	1,601 (b)	1,601	...	1,601	...	
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	5,571 (a)	...	5,571 (b)	5,571	...	5,571	...	
Benares	2,052	...	2,052	2,052	...	2,052	...	
Bijnour	31	...	31	31	...	31	...	
Dehra Dun	701	...	701	701	...	701	...	
Fyzabad	14	...	14	14	...	14	...	
Ghazipur	4,021 (a)	...	4,021	4,021	...	4,021	...	(b) These figures are liable to alteration until publication has been completed.
Gorakhpur	8,615 (a)	...	8,615 (b)	8,609	6	8,615	...	
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,583 (a)	...	3,583 (b)	3,583	...	3,583	...	
Jhansi	1,149 (a)	512	1,661 (d)	...	879	879	782	
Kumaon (Bhaber)	332 (a)	...	332	...	332	332	...	(c) These sheets have been reprinted.
Moradabad and Tarai	4,023	...	4,023	4,023	...	4,023	...	
Muttra	1,658	...	1,658	1,658	...	1,658	...	
Mirzapur	3,794	...	3,794	3,780	14 (c)	3,794	...	
Rampur State	1,349 (a)	7	1,356 (b)	356	1,000	1,356	...	
Tarai	862	...	862	596	266	862	...	
TOTALS	49,471	519	49,990	46,711	2,497	49,208	782	(d) Includes 45 sheets of Jhansi Forest Reserve, surveyed on the scale of 8 inches to the mile.
Burma.								
Akyab	2,785	...	2,785	2,785	...	2,785	...	
Amherst	...	834	834	...	349	349	485	
Bassein	3,437	...	3,437	3,437	...	3,437	...	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Kyaukse	801 (a)	...	801 (b)	196	605	801	...	
Mandalay	...	762	762	...	172	172	590	
Mergui	...	59	59	...	...	...	59	
Prome	847	...	847	847	...	847	...	
Tavoy	...	763	763	...	59	59	704	
Tharrawaddy	1,363	...	1,363	1,363	...	1,363	...	
Thongwa	3,749 (a)	...	3,749 (b)	3,356	393	3,749	...	
TOTALS	18,974	2,418	21,392	17,976	1,578	19,554	1,838	
Bengal.								
Patna and Gya	3,054	...	3,054	3,054	...	3,054	...	
Pooree (Khorda Estate)	4,565	...	4,565	4,565	...	4,565	...	
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
Muzaffarpur	1	...	1	1	...	1	...	
TOTALS	12,544	...	12,544	12,544	...	12,544	...	
Assam.								
Darrang	718 (a)	293	1,011 (b)	704	151	855	156	
Kamrup	1,985 (a)	186	2,171 (b)	1,689	450	2,139	32	
Lakhimpur	...	148	148 (b)	...	34	34	114	
Nowgong	1,273 (a)	...	1,273 (b)	1,071	194	1,265	8	
Sibsagar	1,877 (a)	104	1,981 (b)	1,491	412	1,903	78	
Sylhet	61 (a)	152	213 (b)	16	110	126	87	
TOTALS	5,914	883	6,797	4,971	1,351	6,322	475	
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
TOTALS	43	...	43	43	...	43	...	
GRAND TOTALS	86,946	3,820	90,766	82,245	5,426	87,671	3,095	

Abstract of work performed during 1892-93.

PROVINCES.	NUMBER OF SHEETS. Examined and rendered suitable for Photozincography.	Traced and examined for Zincography.	Proof sheets examined previous to press order.	Coloured and subsequently examined.	REMARKS.
North-Western Provinces	2,361	29	2,525	6	Scale 16 inches=1 mile.
Burma	1,393	1,059	1,197	1,578	Ditto ditto.
Bengal	...	...	...	...	...
Assam	423	364	1,718	...	Ditto ditto.
TOTALS	4,177	1,452	5,440	1,584	

ENGRAVING OFFICE, CALCUTTA.

Statement showing the work performed during the year 1892-93.

Title of Map.	Number of Plates.	Outline, square inches.	Number of letters cut.	Hills, square inches.	Remarks.
Engraving.					
Atlas of India.					
Scale 1 inch = 4 miles.					
Quarter sheets, new, completed	4	17	6,267	96	
Ditto in progress	43	1,000	69,933	558	
Additions and corrections to published quarter sheets	32	68	10,825	27	
Additions and corrections to published full sheets	28	597	60,308	336	
New plates, projected, etc.	1	...	...	...	
General Maps	23	378	44,453	90	
Provincial Maps.					
On scale 1 inch = 16 miles	19	372	28,357	15	
On various scale for Administration Reports.	12	21	3,682	...	
District Maps.					
On scale 1 inch = 4 miles	1	...	3,149	13	
On various scale for Administration Reports	52	633	36,980	90	
Plans	9	...	...	...	
Index Maps	5	2	9,409	...	
Charts	2	246	17,163	...	
Miscellaneous subjects	26	73	35,219	...	
Totals	257	3,407	325,745	1,225	

Copperplate Printing.

Impressions taken	29,527
Proofs pulled	485
Transfers pulled	565
Totals	30,576

Steel-facing.

Double elephant plates, steel-faced	46
Ditto steel removed	28
Quarter sheets, steel-faced	53
Ditto steel removed	19
Miscellaneous plates, steel-faced	26
Ditto steel removed	13
Totals	185

PHOTOGRAPHIC AND

Abstract of Departmental work

Specification.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	*Number of copies.* Coloured.	Uncoloured.	Total.
Departmental Maps and Plans.										
General Maps	33	36	36	20	34	10	4,289	...	2,439	2,439
Provincial Maps	31	45	39	6	22	12	3,438	...	2,225	2,225
Divisional Maps	4	4	4	2	4	...	400	...	400	400
District Maps	43	50	52	19	35	8	2,580	...	2,620	2,629
Plans of Cities and Cantonments	142	2,53	292	143	75	...	2,372	...	2,372	2,372
Standard Maps	481	738	621	229	228	16	27,853	...	27,953	27,953
Index Maps	49	49	69	52	52	11	45,503	26,204	19,074	45,278
Technical Charts	4	9	10	3	4	...	150	...	150	150
Miscellaneous Maps and Plans	294	368	244	101	170	36	34,767	225	40,122	40,347
Transfers and Proofs	...	...	...	...	...	...	3,303	...	...	...
Departmental Forms	14	...	...	...	...	25	60,759	...	69,725	69,725
Type Printing	...	...	...	...	...	...	...	...	...	...
Totals (Normal)	1,095	1,552	1,367	575	624	118	185,414	26,429	167,080	193,509
Cadastral Maps.										
North-Western Provinces—										
Photo-zincographs	2,361	2,361	2,328	2,336	2,336	...	23,319	...	23,319	23,319
Zincographs	139	...	...	139	139	...	1,667	...	1,667	1,667
Totals	2,500	2,361	2,328	2,475	2,475	...	24,986	...	24,986	24,986
Burma—										
Photo-zincographs	1,436	1,436	1,313	1,398	1,398	...	47,641	...	47,641	47,641
Zincographs	242	...	...	242	242	...	8,255	...	8,255	8,255
Totals	1,678	1,436	1,313	1,640	1,640	...	55,896	...	55,896	55,896
Assam—										
Photo-zincographs	406	406	342	314	314	...	16,642	...	16,642	16,642
Zincographs	1,013	...	...	1,013	1,013	...	53,689	...	53,689	53,689
Totals	1,419	406	342	1,327	1,327	...	70,331	...	70,331	70,331
Transfers and Proofs	...	...	...	...	...	...	10,810	...	...	...
Totals (Cadastral)	5,597	4,203	3,983	5,442	5,442	...	162,023	...	151,213	151,213
GRAND TOTALS (Normal and Cadastral)	6,692	5,755	5,350	6,017	6,066	...	347,437	...	318,293	344,722

LITHOGRAPHIC OFFICE.

done during the year 1892-93.

Type Printing.			Silver and other Printing.			Heliogravure and Electro typing.				Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo-blocks.	Electrotypes.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	2,452 9 9	
...	...	...	...	...	...	...	...	...	...	1,759 1 0	
...	...	...	...	...	...	...	...	...	...	155 7 0	
...	...	...	...	...	...	...	...	...	...	4,982 1 0	
...	...	...	...	8	...	...	...	...	...	5,502 9 0	
...	...	...	...	1,681	...	...	...	...	...	22,162 8 0	
...	...	...	...	43	...	...	...	...	...	3,876 14 0	
...	...	...	...	...	...	...	...	...	...	193 3 0	
...	...	...	46	433	...	7	512	...	19	14,329 13 9	
...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	6,759 7 0	
11,210	1,418,607	693,668	...	...	...	...	...	...	...	18,954 11 0	
11,210	1,418,607	693,668	46	2,165	...	7	512	...	19	81,128 4 6	
...	...	...	...	...	...	...	...	...	...	29,825 7 9	
...	...	...	...	...	...	...	...	...	...	749 12 0	
...	...	...	...	...	...	...	...	...	...	30,575 3 9	
...	...	...	...	...	...	...	...	...	...	23,698 6 6	
...	...	...	...	...	...	...	...	...	...	2,181 13 3	
...	...	...	...	...	...	...	...	...	...	25,880 3 9	
...	...	...	...	...	...	...	...	...	...	7,032 14 3	
...	...	...	...	...	...	...	...	...	...	13,115 10 0	
...	...	...	...	...	...	...	...	...	...	20,148 8 3	
...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	76,603 15 9	
11,210	1,418,607	693,668	46	2,165	...	7	512	...	19	1,57,732 4 3	

Statement of work done for other

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	*Number of copies.* Coloured.	Uncoloured.	Total.
Adjutant General in India	39	5	5	...	...	28	46,010	2,400	12,510	14,910
Architectural Surveyor, North-Western Provs. and Oudh	39	39	...	...	...	...	...	...	...	...
Asiatic Society	67	12	1	2	2	5	4,760	...	21,760	21,760
Board of Revenue, Bengal	24	...	...	6	25	37	18,462	10,093	878	10,971
,, North-Western Provinces	9	12	...	...	...	...	...	...	...	...
Calcutta Municipality	18	26	26	17	37	2	2,880	630	2,350	2,980
Chief Commissioner, Assam	...	...	...	...	1	...	2,000	...	4,000	4,000
,, ,, Burma	...	...	...	...	...	3	860	380	100	480
,, ,, Central Provinces	1	...	...	...	...	1	360	...	360	360
Chief Engineer, Bengal, Public Works Department	19	49	49	15	11	9	5,285	710	2,760	3,470
,, ,, Punjab Irrigation Works	18	26	36	13	9	5	7,440	...	12,220	12,220
Commissioner, Ajmere	...	...	...	...	1	...	200	...	200	200
,, Chota Nagpore	...	...	...	3	3	1	1,253	702	200	902
,, Excise, Bengal	5	...	...	...	...	7	2,660	2,280	...	2,280
,, ,, Punjab	2	...	...	...	...	4	860	430	...	430
,, Police, Calcutta	1	...	...	...	...	4	2,198	1,099	...	1,099
,, Salt and Abkari, Madras	...	...	...	...	...	1	450	...	450	450
,, Settlement and Agriculture, Centl. Prov.	9	19	19	7	...	...	1,300	...	1,300	1,300
Commissary General-in-Chief	1	...	3	...	...	1	46	...	46	46
Conservator of Forests, Bengal	10	20	20	6	3	2	178	...	280	280
,, ,, Burma	1	4	4	1	...	...	...	...	...	...
,, ,, Pegu Circle	...	...	...	...	...	...	200	...	200	200
Dewan, Sonepur Feudatory States	...	...	...	...	...	...	12	...	12	12
Director General, Military Works	27	71	61	14	13	1	1,330	...	2,130	2,130
,, ,, Railways	13	...	...	14	35	17	24,276	...	25,326	25,326
,, ,, Telegraphs	62	9	9	9	9	15	9,789	...	24,611	24,611
,, ,, Ordnance	1	...	...	...	...	6	1,317	3,504	...	3,504
,, Geological Survey of India	3	...	...	6	...	26	29,160	3,620	660	4,280
,, Persian Gulf Telegraphs	5	22	22	9	...	...	...	...	...	...
,, Land Records and Agriculture, Assam	3	8	8	3	...	1	440	...	440	440
,, ,, ,, Bengal	4	1	...	...	...	12	3,188	1,056	548	1,604
,, ,, ,, Central Provinces	...	...	...	...	6	...	600	...	600	600
,, ,, ,, Punjab	1	4	4	1	1	...	60	...	60	60
,, Land Records, Gwalior State	2	...	...	...	1	3	9,000	...	15,000	15,000
,, Army Remount Department	1	...	...	...	...	1	54	...	54	54
,, Military Education in India	3	4	4	2	2	4	4,400	2,200	...	2,200
,, ,, Intelligence, Egyptian Army	...	...	...	...	1	...	25	...	25	25
,, Public Instruction, Bengal	4	...	...	...	...	4	2,340	2,340	...	2,340
,, Public Works, Jummu and Kashmir State	...	...	...	...	...	2	750	...	1,000	1,000
,, District Engineer, Muzaffarpur	...	...	...	...	...	...	...	...	...	...
Deputy Collector, Kumaun and Bhabar	...	...	...	...	...	...	100	...	100	100
,, Commissioner, Darjeeling	...	...	...	...	1	...	50	...	50	50
,, ,, Darrang	1	5	5	2	...	...	...	...	...	...
,, ,, Mandalay	2	6	6	4	6	...	2,170	...	1,570	1,570
,, Assistant Adjutant General, Rawal Pindi	2	11	5	4	4	...	400	...	400	400
Engineer-in-Chief, Cuttack-Midnapore-Calcutta Railway	1	...	...	...	...	2	140	70	...	70
,, East Coast Railway	22	22	22	6	3	...	210	...	770	770
,, Kalka-Simla Railway	2	10	10	4	4	...	300	...	300	300
,, Lucknow-Rai Bareilly-Benares Ry.	2	...	...	...	...	3	112	50	12	62
,, Ujjain-Bhopal Railway	11	11	11	3	2	...	180	...	480	480
Engineer, Simla Water Works	9	12	12	4	4	...	200	...	400	400
Electrician, Government Telegraph Department	2	...	...	...	...	14	3,500	500	...	500
Executive Engineer, Fort William Division	...	...	...	...	1	...	100	...	100	100
,, ,, Jummu and Kashmir Division	...	...	...	...	...	...	250	...	500	500
General Officer Commanding Hyderabad Contingent	2	...	...	...	...	3	220	...	220	220
,, ,, ,, Meerut Division	1	2	2	1	2	...	150	...	150	150
,, ,, ,, Secunderabad District	1	4	4	2	2	...	1,300	...	650	650
Government of India, Rev. and Agri. Department	197	136	2	3	12	13	16,362	1,000	15,362	16,362
,, ,, Financial Department	...	...	...	...	...	1	350	...	350	350
,, ,, Foreign Department	36	32	24	18	26	14	7,007	249	6,647	6,896
,, ,, Home Department	8	...	...	...	...	10	5,690	5,600	315	5,915
,, ,, Military Department	11	13	13	9	14	...	657	...	721	721
,, ,, Public Works Department	216	210	205	127	99	27	59,154	8,128	70,987	79,115
,, Bengal, Rev. and General Department	11	...	...	...	2	19	28,828	18,386	7,150	25,536
,, ,, Financial Department	5	...	...	...	...	4	2,512	909	1,600	2,509
,, ,, Judl. and Pol. Department	14	...	...	...	...	10	3,883	4,233	...	4,233
,, ,, Marine Department	6	...	...	...	...	3	700	...	1,440	1,440
,, ,, Public Works Department	4	3	3	2	1	3	2,320	730	190	920
,, Burma, P. W. Department	...	...	...	...	2	...	48	...	48	48
,, N.-W. P. and Oudh, P. W. Dept.	26	23	23	12	15	9	7,023	1,000	6,463	7,463
,, Punjab, P. W. Department	14	27	27	13	16	2	3,123	...	3,527	3,527
,, ,, Rev. and Agri. Department	...	...	...	...	...	3	2,050	...	2,050	2,050
,, Madras, Archl. Department	115	47	43	8	8	...	5,200	...	20,150	20,150
,, Strait Settlements	...	...	...	...	...	...	500	...	500	500
Government Epigraphist, Madras	24	17	16	6	5	...	3,435	...	4,825	4,825
Indian Antiquary, Bombay	...	...	...	...	1	...	805	...	805	805
Indian Museum	16	6	...	3	3	...	60	...	60	60
Inspector General, Civil Hospitals, Bengal	...	...	...	...	1	...	6	...	6	6
,, ,, Civil Veterinary Department	...	...	...	...	...	3	600	200	...	200
Carried over	1,154	928	704	359	395	345	343,778	72,499	278,978	351,477

LITHOGRAPHIC OFFICE.

Departments, etc., during the year 1892-93.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.	Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo. blocks.	Electrotypes.		
...	...	...	...	...	...	...	...	...	...	£ a. p. 2,989 10 9	
...	...	...	...	330	...	12	13	...	...	1,080 9 3	
...	...	...	...	30	...	5	2,105	...	...	1,099 8 3	
...	...	...	...	...	...	...	...	...	...	1,477 2 9	
...	...	...	...	60	...	...	...	...	...	177 0 0	
...	...	...	...	...	...	...	...	...	...	965 9 0	
...	...	...	...	...	...	...	...	...	...	128 13 3	
...	...	...	1,189	...	...	...	...	...	...	854 10 6	
...	...	...	...	...	...	...	...	...	...	30 12 0	
...	...	...	...	...	...	...	...	...	...	1,445 12 9	
...	...	...	...	...	...	...	...	...	...	1,180 3 3	
...	...	...	...	...	...	...	...	...	...	7 12 6	
...	...	...	...	...	...	...	...	...	...	128 15 3	
...	...	...	...	...	...	...	...	...	...	286 15 0	
...	...	...	...	...	...	...	...	...	...	74 0 0	
...	...	...	...	...	...	...	...	...	...	156 14 0	
...	...	...	...	...	...	...	...	...	...	96 4 0	
...	...	...	...	...	...	...	...	...	...	590 13 0	
...	...	...	...	...	...	...	...	...	...	30 0 6	
...	...	...	...	...	...	...	...	...	...	360 0 6	
...	...	...	...	...	...	...	...	...	...	61 3 3	
...	...	...	...	...	...	...	...	...	...	80 9 9	
...	...	...	...	...	...	...	...	...	...	3 0 0	
...	...	...	...	...	...	...	...	...	...	1,057 2 3	
...	...	...	...	...	...	...	...	...	...	2,011 1 9	
...	...	...	...	...	...	...	...	...	...	1,550 5 9	
...	...	...	...	...	...	...	...	...	...	224 10 0	
...	...	...	...	...	...	...	2,200	...	...	2,286 0 9	
...	...	...	...	...	...	...	...	...	...	328 3 3	
...	...	...	...	...	...	...	...	...	...	246 13 9	
...	...	...	...	1	...	...	...	...	...	296 8 3	
...	...	...	...	...	...	...	...	...	...	152 14 6	
...	...	...	...	...	...	...	...	...	...	73 6 6	
...	...	...	...	...	...	...	...	...	...	961 5 0	
...	...	...	...	...	...	...	...	...	...	36 9 0	
...	...	...	...	...	...	...	...	...	...	419 8 9	
...	...	...	...	...	...	...	...	...	...	9 7 9	
...	...	...	...	...	...	...	...	...	...	122 3 0	
...	...	...	...	...	...	...	...	...	...	81 1 0	
...	...	...	...	...	...	...	...	...	...	81 9 0	
...	...	...	...	...	...	...	...	...	...	23 14 0	
...	...	...	...	...	...	...	...	...	...	13 5 6	
...	...	...	...	...	...	...	...	...	...	71 6 6	
...	...	...	...	...	...	...	...	...	...	573 10 6	
...	...	...	...	24	...	...	...	...	...	292 12 9	
...	...	...	...	...	...	...	...	...	...	47 14 0	
...	...	...	...	...	...	...	...	...	...	339 1 9	
...	...	...	...	...	...	...	...	...	...	237 0 6	
...	...	...	...	...	...	...	...	...	...	123 5 9	
...	...	...	...	...	...	...	...	...	...	176 9 6	
...	...	...	...	...	...	...	...	...	...	216 7 6	
...	...	...	...	...	...	...	...	...	...	490 0 0	
...	...	...	...	...	...	...	...	...	...	22 0 6	
...	...	...	...	...	...	...	...	...	...	36 8 0	
...	...	...	...	...	...	...	...	...	...	316 0 0	
...	...	...	...	...	...	...	...	...	...	67 12 9	
...	...	...	...	...	...	...	...	...	...	357 10 3	
...	...	...	...	77	...	35	45,360	68	...	11,139 11 6	
...	...	...	...	...	...	...	...	...	...	88 1 0	
...	...	...	32	...	...	...	...	...	...	2,079 14 3	
...	...	...	...	...	...	...	...	...	...	562 0 0	
...	...	...	...	...	...	...	...	...	...	381 7 6	
...	...	...	...	6	...	3	2,263	...	...	11,681 8 0	
...	...	...	...	...	...	...	...	...	...	1,516 10 0	
...	...	...	...	...	...	...	...	...	...	210 5 0	
...	...	...	...	...	...	...	...	...	...	596 8 3	
...	...	...	...	...	...	...	...	...	...	133 0 0	
...	...	...	...	...	...	...	...	...	...	168 11 3	
...	...	...	...	...	...	...	...	...	...	22 13 6	
...	...	...	...	...	...	...	...	...	...	2,391 4 9	
...	...	...	...	...	...	...	...	...	...	884 7 9	
...	...	...	...	...	...	...	...	...	...	307 3 0	
...	...	...	...	91	...	2	2	...	...	1,324 5 6	
...	...	...	...	...	...	...	...	...	...	117 0 0	
...	...	...	...	...	...	...	...	...	...	565 7 9	
...	...	...	...	...	...	...	...	...	...	48 0 0	
...	...	...	...	...	...	4	1,455	8	...	647 1 9	
...	...	...	...	...	...	...	...	...	...	2 7 3	
...	...	...	...	...	...	...	...	...	...	207 10 0	
...	...	...	1,221	619	...	61	53,398	76	...	61,726 3 6	

Statement of work done for other

Departments, etc.	Sheets or subjects.	Negative and transparencies.	Photo-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies.		
								Coloured.	Uncoloured.	Total.
Brought forward	1,154	928	704	359	395	345	343,778	72,499	278,978	351,477
Inspector General, Jails	1	...	...	...	...	1	60	...	60	60
,, ,, Ordnance	9	8	8	...	4	...	2,832	...	3,540	3,540
,, ,, Police, Bengal	13	...	...	...	2	13	2,730	1,880	2,325	4,205
,, ,, ,, Central Provinces	...	...	...	...	...	2	98	...	343	343
,, ,, Registration, Bengal	1	...	...	...	...	3	1,350	450	...	450
Leprosy Commission	27	4	4	17	59	55	76,065	19,147	11,838	30,985
Manager, Burma State Railway	1	...	...	...	...	1	1,000	...	1,000	1,000
,, North-Western Railway	1	...	...	...	...	2	6,350	...	6,350	6,350
Medical Store-keeper to Govt., Wn. Circle, Mean Meer	...	...	...	...	...	1	200	...	200	200
Mergui Municipality	2	18	18	3	3	...	150	...	150	150
Meteorological Reporter to Government of India	215	26	28	...	1	104	98,880	47,325	77,395	124,720
,, ,, ,, of Bengal	4	...	...	...	...	6	20,532	16	20,520	20,536
Naini Tal Municipality	...	...	...	...	1	...	50	...	50	50
Officer Commanding Allahabad District	...	...	...	...	1	...	80	...	80	80
,, ,, Central India Horse	11	13	18	4	4	...	400	...	400	400
,, ,, Nerbudda District	1	6	6	4	4	...	600	...	600	600
,, ,, Sirhind District	1	4	4	1	1	...	75	...	75	75
,, in Charge, Census Operations, Rajputana	2	...	...	...	...	6	3,030	1,010	...	1,010
Photographic Society, India	3	1	...	...	...	...	...	...	...	...
Political Agent, Rewa Kantha Agency	5	7	7	2	2	...	40	...	40	40
Port Commissioners, Calcutta	2	6	6	2	3	...	710	...	710	710
,, Officer and Registrar of Wrecks, Calcutta	...	...	...	...	...	8	1,020	255	255	510
Post Master General, Bengal	...	...	...	...	9	...	815	...	815	815
Principal, Civil Engineering College, Sibpur	...	...	...	...	...	...	...	...	...	...
Protector of Emigrants, Calcutta	...	...	...	...	...	4	3,944	1,972	...	1,972
Quarter Master General, India	74	109	108	61	62	25	7,902	720	5,581	6,301
,, ,, ,, Burma	1	4	4	2	11	...	2,625	...	2,625	2,625
,, ,, ,, Madras Army	1	...	...	3	3	1	330	...	330	330
Registrar, Chief Court, Punjab	5	...	...	...	...	6	1,680	1,400	...	1,400
Reporter on Economic Products, India	3	...	...	...	...	4	3,168	1,100	1,936	3,036
Sanitary Commissioner, Assam	...	...	...	1	1	...	250	...	250	250
,, ,, Bengal	5	...	...	...	...	7	4,900	2,800	700	3,500
,, ,, India	27	14	...	...	...	6	3,350	1,150	2,100	3,250
,, ,, Hyderabad Assigned Districts	1	...	...	...	...	3	450	200	50	250
,, ,, N.-W. P. and Oudh	1	...	...	...	...	1	25	...	25	25
Secretary for Berar to the Resident at Hyderabad	6	...	...	...	1	1	850	...	4,850	4,850
,, to His Highness the Nizam's Government	16	16	...	...	...	...	...	...	...	...
,, to Lady Dufferin's Fund	2	1	1	...	...	2	3,000	1,500	...	1,500
,, Municipal Committee, Amritsar	3	...	...	...	...	...	...	...	...	...
Settlement Officer, Quetta and Pishin	...	...	...	...	...	1	300	...	300	300
Superintending Engineer, Hyderabad, P. W. Dept.	7	...	...	...	...	8	120	...	60	60
,, ,, Burma Irrigation Circle	...	...	...	...	1	...	100	...	100	100
Superintendent, Census Operations, Bengal	7	...	...	...	...	11	10,450	6,650	...	6,650
,, ,, ,, Berar	14	...	...	...	...	9	6,786	10,556	...	10,556
,, ,, ,, Central Provinces	4	2	2	2	2	5	4,330	1,855	10	1,865
,, Emigration, Calcutta	2	...	...	...	...	2	8	8	...	8
,, Forest Surveys	...	...	...	...	...	12	3,600	300	...	300
,, Government Press, N.-W. P. and Oudh	1	...	...	...	...	3	1,415	350	715	1,065
,, ,, Printing, India	17	2	2	9	13	12	28,136	...	35,738	35,738
,, ,, Records	2	...	1	1	1	5	2,750	500	1,000	1,500
,, Stationery	...	...	...	...	...	3	4,320	...	4,320	4,320
,, Telegraph Stores	...	...	...	...	...	1	1,920	...	960	960
Surgeon General, Central Provinces	...	...	...	...	1	...	275	...	275	275
Special work done for Trade and Private Individuals	21	22	7	4	5	11	21,396	250	20,921	21,171
TOTAL	1,673	1,191	928	475	590	690	679,245	173,893	488,570	662,463

LITHOGRAPHIC OFFICE.

Departments, etc., during the year 1892-93—contd.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.			Remarks.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo. blocks.	Electrotypes.	R	a.	p.	
...	...	...	1,221	619	...	61	53,398	76	...	61,726	3	6	
...	...	...	...	...	...	...	...	...	...	46	13	0	
...	...	...	...	...	...	...	...	...	...	218	10	6	
...	...	...	...	...	...	...	...	...	...	334	8	0	
...	...	...	...	...	...	...	...	...	...	11	6	0	
...	...	...	...	...	...	...	...	...	...	134	1	0	
...	...	...	...	...	...	...	...	...	...	3,664	7	9	
...	...	...	...	...	...	...	...	...	...	78	8	0	
...	...	...	...	...	...	...	...	...	...	256	8	0	
...	...	...	...	...	...	...	...	...	...	29	11	0	
...	...	...	...	...	...	...	...	...	...	246	15	9	
...	...	...	...	...	...	...	...	...	...	6,264	0	0	
...	...	...	...	...	...	...	...	...	...	540	2	0	
...	...	...	...	...	...	...	...	...	...	18	11	0	
...	...	...	...	...	...	...	...	...	...	20	4	0	
...	...	...	...	...	...	...	...	...	...	335	10	6	
...	...	...	...	...	...	...	...	...	...	264	8	6	
...	...	...	...	...	...	...	...	...	...	78	0	3	
...	...	...	...	...	...	...	...	...	...	211	5	6	
...	...	...	...	...	...	1	6,002	2	...	366	0	0	
...	...	...	...	...	...	...	...	...	...	129	14	3	
...	...	...	...	...	...	...	...	...	...	176	6	6	
...	...	...	...	...	...	...	...	...	...	300	12	0	
...	...	...	...	...	...	...	...	...	...	258	13	6	
...	...	...	...	...	...	...	150	...	...	18	0	0	
...	...	...	...	...	...	...	...	...	...	246	3	9	
...	...	...	2	...	...	7	809	2	...	5,570	4	0	
...	...	...	...	...	...	...	...	...	...	601	11	3	
...	...	...	...	...	...	...	...	...	...	592	6	9	
...	...	...	...	...	...	...	...	...	...	169	8	0	
...	...	...	...	...	...	...	...	...	...	338	2	0	
...	...	...	...	...	...	...	...	...	...	21	5	0	
...	...	...	...	...	...	...	...	...	...	269	1	0	
...	...	...	...	24	...	7	9	...	...	942	2	0	
...	...	...	...	...	...	...	...	...	...	76	13	0	
...	...	...	...	...	...	...	...	...	...	90	14	0	
...	...	...	...	...	...	...	...	...	...	81	3	0	
...	...	...	...	64	...	...	...	...	...	165	7	3	
...	...	...	...	...	...	...	...	...	...	110	1	0	
...	...	...	...	...	...	...	...	...	...	137	11	0	
...	...	...	...	...	...	...	...	...	...	75	0	0	
...	...	...	...	...	...	...	...	...	...	436	10	0	
...	...	...	...	...	...	...	...	...	...	34	15	3	
...	...	...	...	...	...	...	...	...	...	494	14	0	
...	...	...	...	...	...	...	...	...	...	394	4	0	
...	...	...	...	4	...	...	...	...	...	284	14	0	
...	...	...	...	...	...	...	...	...	...	12	12	0	
...	...	...	...	...	...	...	...	...	...	950	0	0	
...	...	...	...	...	...	...	...	...	...	199	10	0	
...	...	...	...	...	...	...	...	...	...	902	4	6	
...	...	...	...	...	...	...	...	...	...	653	5	6	
...	...	...	...	...	...	...	—	...	...	223	13	0	
...	...	...	...	...	...	...	...	...	...	51	0	0	
...	...	...	...	16	...	2	202	...	...	1,223	0	9	
...	...	...	1,223	727	...	78	60,570	80	...	91,118	1	6	

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Detail of Issue to, and Receipts from, Provinces and Departments during the financial year 1892-93.

PROVINCES AND DEPARTMENTS.	RECEIPTS.	ISSUES.	DEBITS.	CREDITS.
	Value.	Value.	Value.	Value.
	₹	₹	₹	₹
Assam	806	13,054	12,248	...
Bengal, Civil	4,861	40,471	35,610	...
„ Military (East)	33	2,295	2,262	...
„ „ (West)	1,455	8,216	6,761	...
Berar	...	121	121	...
Bombay, Civil	1	1,155	1,154	...
„ Military	515	1,940	1,425	...
Burma	3,609	39,577	35,968	...
Central India	...	175	175	...
Central Provinces	299	11,119	10,820	...
Colonial Government, Straits Settlements	...	370	370	...
Forests	...	3,557	3,557	...
Geological Surveys and Museums	410	385	...	25
Guaranteed Rys., East Indian Railway	...	1,226	1,226	...
Law and Justice, Port Blair	...	26	26	...
Land Revenue, Coorg	...	194	194	...
Land Revenue	...	306	306	...
Hyderabad, P. W. D.	1,541	69	...	1,472
Madras, Civil	10,628	10,607	...	21
„ Military	1,123	6,540	5,417	...
Marine	343	1,554	1,211	...
Meteorological Department	333	1,952	1,619	...
Mint	655	37	...	618
N.-W. Provinces and Oudh	402	7,690	7,288	...
N.-W. Sate Railway, P. W. D.	227	4,587	4,360	...
P. W. D., Military Works	209	6,274	6,065	...
P. W. D., Coorg	25	293	268	...
P. W. D., Baluchistan, Railway Branch	361	12,626	12,265	...
„ „ Ordinary „	3	264	261	...
Political	...	76	76	...
Punjab	12,144	35,882	23,738	...
Rajputana-Malwa Railway	...	78	78	...
Rajputana, P. W. D., and Central India	27	213	186	
Survey of India, Field Parties	12,675	66,878	54,203	
Ditto Head-quarters Offices	5,232	6,918	1,686	
Telegraph	32	328	296	
TOTAL	57,949	2,87,053	2,31,240	2,136
NET DEBIT	...	...	2,29,104	...
CASH SALES	...	28,186	28,186	...
GRAND TOTAL	...	...	2,57,290	...

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1892-93.

Specification.	Number.	Value.	
		₹	a.
Instruments.			
Barometer, aneroid, ordinary pocket	2	125	0
" " " Watkins'	1	65	0
Cases, leather and Morocco	13	66	0
Chains, iron, 30 feet	50	125	0
" " 66 "	80	280	0
" " 100 "	39	263	0
Clinometers, survey pattern	25	388	3
Clocks	3	85	0
Compasses, drawing, ordinary, brass, 5-inch	3,290	3,291	14
" " " " 6 "	50	75	0
" magnetic rectangular, 2½ "	27	174	0
" " " 5 "	6	84	0
" " " 6 "	55	792	8
" proportional, brass, 6 "	1	10	0
" " electrum, 6 "	12	301	8
Covers for plane tables	25	148	8
Glasses, binocular, telescopic	1	100	0
" magnifying or reading in metal flame, 4½-inch	3	22	14
Glasses, time	25	68	8
Instruments, drawing, brass, 2nd sort	6	255	0
" " electrum, 1st sort, with needle points	1	78	12
" " " 2nd sort	17	755	0
Knives for instrument boxes	1	1	0
Levels, Dumpy, 14 inch	2	560	0
" reflecting, Abney's	6	210	0
" reversible, 14-inch	3	810	0
" " 16-inch	1	300	0
" spirit, in wooden case, 8-inch	24	60	0
Map printing-machine, Ordnance	12	510	0
Numbers of chains, sets	2,800	787	8
Pencil leads for instruments	2	2	0
Pens, drawing, ivory handles	196	373	4
" double or road	2	12	8
Pins for chains, ordinary	22,006	1,399	0
" for maps, brass	792	44	0
" " electrum	576	50	8
Plane tables, deal, survey	49	331	0
Protractors, horn	9	43	0
Pyrometer	1	47	5
Range-finders	4	304	0
Rules, carpenters,' wooden, 2 feet, 4-fold	36	42	12
" plate, ebonite, plain, 6-inch	500	187	8
" " " " 12-inch	870	876	4
" parallel bar, wooden, 6-inch	25	18	12
" " on rollers, brass, 15-inch and 18-inch	13	340	4
" " " " " 2 feet to 3 feet	8	287	8
" " " " electrum, 12-inch	1	60	0
" sight, wooden	649	1,947	0
Scales, architects,' boxwood, sets	15	217	4
" " " single	14	35	2
" " " ivory, sets	1	47	4
" diagonal, wooden	1,500	703	2
" marquois, wooden, set	3	37	8
" offsets, single, ivory	2,860	1,030	5
" plotting, sets, wooden	17	364	8
" " single, ebonite	2	4	8
" " " wooden	64	182	0
Carried forward	36,796	19,781	5

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1892-93.—contd.

SPECIFICATION.	Number.	Value. R	Value. a.
Brought forward	36,796	19,781	5
Instruments—contd.			
Set squares, set, ebonite	12	90	0
„ „ „ wooden	11	50	8
„ „ single, ebonite	168	284	4
Slide-rule	1	24	0
Squares, optical	1,321	8,586	8
Stands for levels, Dumpy and Y	6	220	0
Stands for plane tables	1,056	7,392	0
„ „ „ „ military	12	216	0
Stencil plates	6	8	5
Tapes, metallic, 50 feet	422	1,746	4
„ „ 66 „	4	22	0
„ „ 100 „	50	362	8
„ steel, 50 „	10	130	0
„ „ 100 „	9	207	0
„ „ of sizes	2	14	0
Telescope, spare, for pocket sextant	3	32	7
Thermometer, common, in tin case	1	6	8
„ minimum, self-registering	3	48	0
TOTAL	39,893	39,221	9
Books.			
Hints to Travellers	9	43	3
Manual of Surveying	6	72	0
Nautical Almanacs	100	175	0
Tables, Barometrical, Mackesy's	50	100	0
„ for Hypsometers	2	2	0
„ Log, Chambers'	49	150	5
„ Traverse, Boileaus'	24	195	12
Brühn's Manual of Logarithms	25	115	10
TOTAL	265	853	14
Sundries.			
Brushes, stencil, medium size	36	18	12
Bottle, ink, for pads	4	2	0
Brass boxes and fittings for rectangular compass, 5-inch	25	262	8
„ „ „ „ „ 6-inch	25	287	8
Cards for Draper's thermometers	150	30	0
Cash box	1	14	0
Compass, magnetic, Vernier's	2	115	0
Geneva lens-tester	1	32	12
India-rubber tubing	2	4	8
Pads for rubber	4	0	8
Silk cover, wire	1	0	8
Stencil, ink	24	24	0
Teak wood measuring rod	150	187	8
Thermometer, deep sea	1	27	0
Thermometer, oven	1	42	4
Typing ink	4	7	12
TOTAL	431	1,056	8
TOTAL OF BOOKS	265	853	14
„ OF INSTRUMENTS	39,893	39,221	9
GRAND TOTAL	40,589	41,131	15

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1892-93.

SPECIFICATION.	Number.	Value. R	Value. a.
Instruments.			
Bars, standard, steel	3	77	0
Boards, drawing, deal	50	664	0
,, ,, and sketching, cavalry pattern	2	26	0
Case, leather	1	12	0
Chains, iron, 33 feet	460	1,150	0
,, ,, 66 ,,	2,582	8,862	0
,, ,, 100 ,,	170	1,229	8
,, steel	85	894	0
,, of various kinds and sizes	103	266	8
Clinometers, survey pattern	50	1,590	0
,, wooden shade scales	12	18	0
Combs, acre, cardboard	1,547	573	14
Compasses, magnetic, rectangular, 5-inch	137	1,866	0
,, ,, ,, 6-inch	74	1,085	0
Glasses, copying or tracing	11	563	2
Heliotropes, 6-inch	12	600	0
Hydrometers, Sykes' glass floats	1	24	12
Lamps, bull's-eye	12	42	0
,, referring	12	60	0
Levels, field service	1	32	0
Pins for chains, ordinary	19,250	1,293	12
Plane tables, deal, survey	1,186	7,725	0
,, ,, ,, military	24	84	0
,, teak and others	2	14	0
Pluviometer, self-registering	1	20	0
,, Symons'	1	16	0
Protractors, cardboard, circular, 9-inch and 12-inch	102	127	8
Rods, measuring	150	375	0
Rules, flat, ebonite, plain, 6-inch and 9-inch	82	34	14
,, ,, ,, ,, 12-inch	22	25	0
,, ,, wooden ,, 12-inch and 18-inch	450	81	4
,, sights, brass	18	168	0
Scales, architects', boxwood, sets	9	90	0
,, ,, ebonite, ,,	1	16	0
,, ,, ivory, ,,	6	240	0
,, cardboard, miscellaneous	1,525	381	4
,, diagonal, cardboard	9,750	2,218	12
,, ,, metal, 2-inch to the mile	22	85	8
,, ,, ,, 6 ,, ,, ,,	6	24	0
,, horn	200	125	0
,, ,, sheets	102	52	0
,, offsets, sets, wooden	38	9	8
,, ,, single, ivory	17	4	8
,, plotting sets, ebonite	4	79	0
,, ,, single, metal	24	180	0
,, ,, ,, wooden	1	5	0
,, celluloid	340	180	0
Stamps for conventional signs	6	6	0
Stands for heliotropes	12	216	0
,, ,, plane tables	155	1,085	0
,, ,, ,, military	14	268	0
,, ,, theodolite, Everest's, 5-inch	1	20	0
Staves, levelling, Roorkee, double	26	648	0
,, ,, ,, single	24	336	0
,, ,, Sopwith's telescopic	50	1,250	0
,, subtense	34	688	0
Stencil plates	280	517	2
Sun-dials	4	241	8
Thermometer cages	2	20	0
Yards, standard	75	474	0
TOTAL	39,341	38,970	4

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1892-93—contd.

SPECIFICATION.	Number.	Value.
Books.		₹ a.
Tables, auxiliary for facilitating computation of trigonometrical surveys, Hennessey's	25	50 0
Tables for hypsometers	50	50 0
„ log. to 5 places decimals	100	25 0
TOTAL	175	125 0
Sundries.		
Boards for barometers	12	120 0
Cases, wood, for minimum thermometers	1	3 8
Clamping screw for plane tables	9	13 8
Conventional signs	10	3 12
Field writing tables	275	550 0
Gauges, electrum	100	225 0
Handles, brass, for chains	10	3 12
Level, water, with stand	1	5 0
Metal, arm	1	10 0
Plan board with trestles	1	18 0
Plates and screws for subtense bars	12	42 0
Scales, electrum, for levels	4	16 0
„ metal, brass, 6-inch	3	52 0
„ divided into centimeters and millimeters	1	10 0
„ plotting, 2 inches = 1 mile	1	7 8
„ square, 12-inch, boxwood	1	10 0
Screw-driver	1	1 0
Screws, brass, for backboard for barometer	24	5 0
Sight rules for subtense bars	8	80 0
Tide-gauge measure	6	108 0
Tin tube	1	1 12
Type-holder	1	32 0
Zinc mullers	6	13 8
„ plummet, 3½-inch diameter	1	2 4
Type frame for machine map printing	1	32 0
TOTAL	491	1,365 8
TOTAL OF BOOKS	175	125 0
„ OF INSTRUMENTS	39,341	38,970 4
GRAND TOTAL	40,007	40,460 12

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of Principal Instruments repaired in Workshop during the financial year, 1892-93.

Specification.	Number.
Airmeter	1
Anemometers of sorts	49
Arithmometers	6
Azimuth mirror	2
Barometers of sorts	93
Board, drawing	1
Callipers, sliding, 18-inch, in case	2
Camera	1
Chains, of sorts	47
Chronometers	8
Chronograph	1
Chronomicrometer	1
Clinometers	51
Clocks, of sorts	5
Comb, acre	1
Compasses, beam, of sorts	5
,, boat	6
,, bow, pen, of sorts	45
,, ,, pencil	5
,, ,, dividers, spring	2
,, field	1
,, drawing, of sorts	185
,, hair, of sorts	10
,, magnetic, of sorts	12
,, marine	2
,, Pelaries	1
,, prismatic, of sorts	127
,, proportional	6
Comptometers	2
Compasses, rectangular	84
,, surveying, of sorts	38
Glasses, binocular	60
,, copying or tracing	1
Graduated squares	6
Heliographs	62
Heliotropes	13
Horse-measuring standard	1
Horse-testing machine	1
Hydro-clinometers	2
Hydrometers	99
Hygrometers	3
Instruments, drawing, mathematical, of sorts	63
,, time of flight	6
Lamps of sorts	6
Lengthening bar	1
Lenses, reading	2
Levels, of sorts	128
,, reflecting, Abney's	6
,, spirit	26
Litho machine	1
,, press	1
Machine, map printing	1
Magnets, bar	3
Micrometer and hour circle of an equatorial	1
Omnimeter	1
Optical squares	159
Pens, drawing, of sorts	128
Pen, legs, of sorts	3
Pencil legs	2
Carried forward	1,586

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of Principal Instruments repaired in Workshop during the financial year 1892-93—concluded.

Specification.	Number.
Brought forward	1,586
Pentagraph	1
Perambulator	1
Plane tables, of sorts	13
Planimeters, of sorts	11
Pointer, station	1
Presses, of sorts	9
Protractors, of sorts	4
Pyrometer	1
Quintants	7
Raingauges	16
Range finders, of sorts	32
Rules, of sorts	24
Rules, sight, of sorts	76
Saccharometers	7
Scales, of sorts	4
Scott's sight, telescopic	17
Sextants, of sorts	11
Squares, of sorts	10
Stands, for compasses	75
„ for heliographs	24
„ for levels	80
„ for plane tables	2
„ for theodolites	58
Stadiometer	1
Staves, levelling, of sorts	108
Sundial	1
Tapes, of sorts	227
Telemeters	2
Telescopes, of sorts	99
Theodolites, of sorts	109
Thermometers, of sorts	32
„ for hydrometers	12
Type-writers	5
Watches, of sorts	18
Wind vane	1
TOTAL OF PRINCIPAL INSTRUMENTS REPAIRED	2,685
„ „ MINOR INSTRUMENTS REPAIRED	957
TOTAL OF ALL INSTRUMENTS REPAIRED	3,642

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D—*concld.*

Profit and Loss Account of the Workshop for the financial year, 1892-93.

DEBITS.			CREDITS.		
	₹	a.		₹	a.
Workshop establishment (less proportion debitable to the Store Branch for cleaning and adjustment of serviceable instruments)	32,383	12	By repairs for public officers on book debit ₹13,195 1	17,603	9
One third of office establishment	2,025	10	By repairs for public officers on payment ₹4,408 8		
Pay of Material store-keeper for the whole year	780	0	By repairs for stock	25,024	7
Workshop contingencies, as distinguished from materials purchased	2,347	5	By manufactures for stock :—		
Value of materials :—			Instruments	38,957	6
For special works			Packing cases	1,913	5
„ general workshop use	39,116	11			
„ manufacture of packing cases			By manufacture of materials	3,013	4
Paid for repairs	186	8			
Wear and tear of plant	1,607	0			
Half of rent at ₹600 per mensem	3,600	0			
Printing and stationery	396	15			
Four per cent. on value of tools and plane amounting to ₹94,060	3,762	6			
Profit	305	12			
TOTAL	86,511	15	TOTAL	86,511	15

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Extract from the Narrative Report of MR. J. ECCLES, M.A., *Deputy Superintendent, 2nd grade, in charge Computing Party.—Season 1892-93.*

The changes which took place in the personnel during the year under report are the following :—

In the Computing section, two computers retired on superannuation pension, and one resigned ; in the Drawing section, Babu Sham Lal, the senior draftsman, whose health had been in a failing state for some time, died on the 30th August 1893.

The cost of the Computing section under its various class heads, and the per centages thereof, with those of the three prior years, are given in the following statement :—

CLASS.	COST IN RUPEES.	PERCENTAGE OF COST.			
	1892-93.	1892-93.	1891-92.	1890-91.	1889-90.
1. Records, library	1,252	2·6	3	3	4
2. Accounts, returns, correspondence	2,578	5·4	4	5	5
3. Supply of data, etc.	1,074	2·3	3	1	2
4. Computations	9,534				
5. Preparation of press copy	19,831	79·5	79	74	71
6. Examination of press proofs	8,409				
7. Ditto of charts	696	1·5	2	4	1
8. Protection of stations	573	1·2	1	1	2
9. Miscellaneous	2,923	6·2	6	9	11
10. Meteorology and general science	542	1·1	1⅔	2	2
11. Extra departmental work	105	0·1	⅓	1	2
TOTAL	47,517	100	100	100	100

The percentage for classes 4, 5, and 6 is again good as compared with those for the years 1889-90 and 1890-91 ; the other classes need no remark, excepting class 2, of which the percentage is higher than usual, due entirely to the cost of binding of 350 copies of each of the Synoptical Volumes XXVII, XXVIII, XXX, XXXI, XXXII, and 400 copies of the Auxiliary Tables, which has been included in this class.

The following is an account of the work done under the several classes shown in the foregoing table :—

CLASS 1.—RECORDS, LIBRARY, ETC.—Five fresh instalments of field records were received during the year ; these, together with the great mass already stored in the office, have received the usual care and attention. As regards the library, the three standard copies of the Catalogue have been kept up to date for all books and periodicals as they come to hand.

CLASS 2.—ACCOUNTS, RETURNS AND CORRESPONDENCE.—This includes the preparation of indents, estimates, monthly detailed and abstract progress reports, annual report, stock returns of office stores, and various other items. The cost of binding five Synoptical Volumes and the Auxiliary Tables is also included in this class.

CLASS 3.—SUPPLY OF DATA.—Nine requisitions for data of various kinds have been met ; the work connected with the despatch of maps, charts, books, and forms is also included under this head.

CLASS 4.—COMPUTATIONS.—These will be found detailed below ; they mostly appertain to the secondary work of the South-West and North-East Quadrilaterals. The progress made is as follows.—

The final reduction of the Kathiawar Meridional series stands completed ; that of the North-East Longitudinal series has been taken in hand and some progress made ; but as the field records appertaining to it extend over a period of about forty years, and are to a great extent in an incomplete state, this will entail some very heavy work before the computation can regularly be proceeded with.

The small Catalogue of Stars for the epoch, 1st January 1892, as deduced from the observations of this department, has been completed ; this engaged a pair of computers nearly six months.

Electro-Telegraphic Longitude.—The revision of the remaining two arcs of Professional Volume IX has been completed ; this took up the time of a pair of computers for half a month.

Burma Coast Series, Section 11° to 23°.—The revision of weights of observed angles and of reduction of figures, where necessary, has been completed for the whole series.

The remainder of the work of this class was of a miscellaneous character.

CLASS 5.—PREPARATION OF PRESS COPY.—This entails abstracting and compiling the final results of the various calculations in a suitable form for publication : all such abstracts

have to be twice compared, both against the original field records and the final calculations prior to being sent to the press. The details of the work done are as follows:—

(*a*) *Southern Trigon.*—Very considerable progress has been made with the preparation and final revision of the several tabular statements for the Synoptical Volume of the Great Arc Meridional series, section 8° to 18°; this may be considered about half done.

(*b*) *South-West Quadrilateral.*—The progress made with the preparation of the several tabular statements for the Synoptical Volumes has been likewise very considerable; those for the Khánpisura Meridional, Singi Meridional, and Cutch Coast series, which were reported half done last year, have been completed and passed through the press, and that for the Kathiawár Meridional series may be considered well advanced; the last table, the co-ordinate list, standing compiled and needing only the final revision.

(*c*) The pamphlet of spirit-levelled heights, No. 7, Bombay Presidency, Hyderabad Assigned Districts and Central Provinces, was passed through the press.

(*d*) *Electro-Telegraphic Longitude.*—The last hundred pages of Professional Volume XV were compiled, examined, and passed through the press.

(*e*) *Tidal Volume.*—Good progress has been made. Thirty-two pages of Part I and 60 pages of Part II have been finally examined and passed through the press. Thirty-six pages of Part I are also in type, and are expected to be shortly ready for final printing.

(*f*) *Burma Coast series.*—One hundred and fifty pages of the observed angles and reduction of figures were prepared, examined and passed through the press. This was done to keep the presses fully engaged when unavoidable interruptions occurred with the regular work. Any further help of the kind cannot be expected from this triangulation, as compilation in continuation can only be resumed after the simultaneous reduction of the whole of the principal triangulation in Burma has been finally completed.

(*g*) *Star Catalogue.*—A small Catalogue of Stars for the epoch January 1, 1892, as determined from the observations taken in connection with the operations of the Trigonometrical Branch of this department was prepared, examined and passed through the press. This work is now being bound and will shortly be ready for issue.

(*h*) *North-east Quadrilateral, Secondary work.*—The compilation of description of principal stations of the north-east longitudinal series has been taken in hand, and may be considered as about half done.

CLASS 6.—EXAMINATION OF PRESS PROOFS.—This involves the final revision of proofs, all requiring the utmost care in comparison and examination in the several stages of *first*, *second* and *forme* proofs. Most of the matter printed is numerical or depending on numerical data; hence, it necessarily requires a strictly critical examination which can only be made by men specially trained to this style of work.

The printing of the following works has been completed during the year:—

(1) Professional Volume XV (Electro-Telegraphic Longitudes).
(2) Synoptical Volume XXVII.
(3) „ „ XXVIII.
(4) „ „ XXX.
(5) „ „ XXXI.
(6) „ „ XXXII.
(7) „ „ XXXIII.
(8) Pamphlet of spirit-levelled heights, No. 7, Bombay Presidency, Hyderabad Assigned Districts and Central Provinces.
(9) Catalogue of Stars for the epoch January 1, 1892, from observations by the Great Trigonometrical Survey of India.
(10) Catalogue of Books of the Forest School Library.

No. 1 has been bound and is ready for issue, Nos. 2 to 6 and 8 have been bound and issued; Nos. 7 and 9 are in the hands of the binder.

The printing of Synoptical Volume XXXIV, Káthiáwár Meridional Series, is well advanced, and the letter-press will be ready for binding by April next, but the binding of the volume will be delayed on account of the final chart, which is in a very backward state.

Burma Coast series.—The printing of the details of the observed angles and the preliminary reduction of figures has been completed. No further progress can be made with this work pending the simultaneous reduction, as already noted under class "Press Copy."

Tidal Volume.—Good progress has been made with this work.

CLASS 7.—EXAMINATION OF CHARTS.—The following charts were examined and passed for the press:—

(1) Five final charts for Synoptical Volumes XXXI, XXXII and XXXIII.
(2) One level chart for pamphlet of spirit-levelled heights, No. 7, Bombay Presidency.

In addition, four rough working charts for North-east Longitudinal series were prepared to aid the computers in their work.

CLASS 8.—PROTECTION OF STATIONS.—The usual professional aid in connection with the protection of survey stations and certain of the bench-marks in the North-Western Provinces has been rendered by the Computing section to the office of the Deputy Surveyor-

General. During the year 645 stations have been repaired by the district officers at a cost of R2,09638-9. Fifteen districts out of 334, from which reports are due, failed to submit them.

CLASS 9.—MISCELLANEOUS.—In this is included various duties which cannot fairly be assigned to any of the other classes, such as the following:—

(*a*) The taking and reducing of observations for time at Mussooree and Dehra, for rating clock and chronometers, and for giving the signal for the 12 o'clock gun at Mussooree.

(*b*) The preparation of examination papers for the Senior and Junior divisions of the Survey of India Department, of which one set for the Senior and fifteen sets for the Junior divisions were prepared, examined, and the results tabulated for submission to the Surveyor-General.

(*c*) The examination and despatch of printed papers to the Survey of India Office, Calcutta, for safe custody; the giving out of printed pages of professional and synoptical volumes to binders; the examination of all bound volumes and pamphlets prior to issue, and the preparation of the distribution lists and presentation labels for the same, etc., etc.

CLASS 10.—METEOROLOGY AND GENERAL SCIENCE.—As hitherto, a complete set of meteorological observations was taken daily throughout the year, and monthly and annual abstracts prepared. The results are given in the following tabular statements:—

MEAN MONTHLY READINGS OF EARTH THERMOMETERS.

Depth in feet of thermometer bulbs below surface of ground.	YEAR.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1892-93	77·67	77·57	77·42	77·03	76·52	75·82	74·90	74·30	74·06	74·27	75·36	76·10
	Mean 1881—92	76·72	76·81	76·60	75·92	75·36	74·79	74·29	74·06	74·05	74·36	75·41	76·50
12·8	1892-93	80·06	78·98	77·15	74·97	72·80	70·56	70·36	71·98	74·14	77·10	78·89	79·51
	Mean 1881—92	79·38	77·90	75·52	72·87	71·27	70·67	71·41	73·21	75·26	77·10	79·03	79·06
6·4	1892-93	79·89	76·47	71·83	67·60	64·13	64·33	69·15	75·20	78·86	80·47	81·65	81·00
	Mean 1881—92	79·64	75·62	71·00	67·18	65·59	67·34	71·73	76·78	80·12	81·26	81·38	31·22
3·2	1892-93	78·17	72·21	66·11	60·94	58·18	62·80	73·07	80·50	82·24	81·87	82·75	80·71
	Mean 1881—92	78·12	71·01	65·55	61·99	61·46	66·96	75·55	81·70	84·71	83·42	82·10	81·66
1·1	1892-93	76·38	67·47	60·06	55·16	54·25	62·32	76·53	83·98	84·07	82·67	82·89	80·03
	Mean 1881—92	75·98	67·44	60·22	57·48	58·64	67·97	79·06	85·46	88·18	84·17	82·42	81·68
Thermometer in shade.	1892-93	79·92	72·89	66·67	158·75	58·41	71·71	86·54	87·25	84·09	80·03	81·88	80·12
	Mean 1881—92	80·71	73·81	68·49	64·72	67·59	79·22	90·38	93·71	91·26	82·57	80·66	82·55

Mean velocity in miles of the Winds which blew at Dehra Dun during the twelve months of 1892-93 for each hour of the day.

CIVIL HOURS.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Mean.
0 to 1	1·39	1·21	0·74	0·58	0·71	1·31	0·97	0·81	0·71	0·33	0·52	0·83	0·84
1 „ 2	1·16	0·86	0·74	0·42	0·68	1·38	1·34	0·81	0·50	0·37	0·71	0·83	0·82
2 „ 3	0·81	0·45	0·68	0·26	1·00	1·07	0·97	0·71	0·54	0·43	0·45	0·67	0·67
3 „ 4	0·61	0·34	0·29	0·42	0·46	1·07	0·52	0·58	0·46	0·40	0·58	0·57	0·53
4 „ 5	0·74	0·34	0·16	0·42	0·39	1·00	0·66	0·52	0·50	0·13	0·42	0·37	0·47
5 „ 6	0·35	0·34	0·26	0·48	0·25	1·00	0·59	0·77	0·32	0·10	0·32	0·47	0·44
6 „ 7	0·35	0·31	0·32	0·48	0·29	1·07	0·48	0·52	0·29	0·47	0·55	0·63	0·48
7 „ 8	0 10	0·14	0·29	0·39	0·43	0·86	0·45	0·58	0·46	0·57	0·65	0·40	0·44
8 „ 9	0·06	0·17	0·16	0·52	0·54	0 97	0 76	1·00	0·36	0·83	0·87	1·03	0·61
9 „ 10	0·61	0·39	0·58	0·58	0·71	1·79	1·31	1·71	0·68	1·07	1·13	1·20	1 00
10 „ 11	1·42	1·29	1·00	0·87	1·04	2·17	1·79	2·23	1·00	1·17	1·48	1·40	1·41
11 „ 12	1·61	1·39	1·16	1·32	1·29	2·52	2·34	2·13	1·81	1·60	1·20	1·43	1·65
12 „ 13	1 42	1·83	1·52	1·65	1·82	2·66	2·50	2·16	1·54	1·90	1·52	1·97	1·87
13 „ 14	1·57	2·03	1·94	1·77	2·11	3·39	2·64	2·39	1·61	1·97	2·03	1·77	2·10
14 „ 15	1·50	2 03	2 16	2·03	2·68	3·57	3·28	2·68	1·71	1·83	1·81	2·13	2·28
15 „ 16	1·50	1 31	1·55	1·81	3·04	3·36	3·38	2·42	2·93	1·60	1·32	1·63	2·15
16 „ 17	0·57	0·27	0·48	1·84	2·54	3·45	3·07	2·42	1·93	1·03	0·74	1·60	1·66
17 „ 18	0·00	0·33	0·23	1·03	1·64	2·34	1·41	1·29	1·11	0·70	0·42	0·87	0 95
18 „ 19	0 27	1·03	0·23	0·23	1·29	0·97	0·89	0·94	0·61	0·57	0·16	0·47	0·64
19 „ 20	1 17	1·83	0·55	0·13	0·89	1·14	1·48	1·00	0·43	0·40	0·06	0·43	0 79
20 „ 21	1·30	2·03	0·97	0·19	0·57	1·21	1·62	1·00	0·75	0·30	0·32	0·53	0·90
21 „ 22	1·67	2·10	1·03	0·32	0·75	1·41	1·97	1·16	0·54	0·43	0·26	0·70	1·03
22 „ 23	1·83	2·10	1·03	0·42	0·50	1·66	1·48	0·81	0·89	0·23	0·48	0·63	1·01
23 „ 24	1·63	1 70	0·97	0·61	0·82	1·41	1·45	0·77	0·54	0·40	0·65	0·80	0·98
Sums	23·64	26·02	19·04	18·77	26·44	42·78	37·35	31·41	22·22	18·83	18·65	23·36	...
Average	0·99	1·08	0·79	0·78	1·10	1·78	1·56	1·31	0·93	0·78	0·78	0·97	...

Monthly Meteorological Results of observations taken at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun.

Year and Month.	Barometer reduced to 32° Fah.						Hygrometer.		Thermometer.				Rain.		Wind.	Cloud.	
	At 10 A.M.			At 4 P.M.			10 A.M.	4 P.M.	Dry Bulb.			Wet Bulb.					
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Mouthly mean.	Monthly mean humidity.	Monthly mean humidity.	Highest Maximum in Air.	Lowest Minimum in Air.	Monthly mean in Air.	Lowest Minimum.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 10 A.M.	At 4 P.M.
1892.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	°	°	°	°	°	°					
October	27·782	27·539	27·687	27·683	27·470	27·604	54	48	84·5	56·0	69·4	53·2	...	...	...	0	1·2
November	·844	·605	·745	·760	·536	·674	50	45	78·1	43·1	60·3	39·6	...	...	S. W. & W.	0·8	1·0
December	·926	·708	·827	·834	·636	·750	52	49	75·5	40·8	55·1	38·0	1	0·75	S. & W.	2·8	3·4
1893.																	
January	·902	·603	·743	·805	·552	·666	72	62	67·2	34·4	50·7	33·8	8	4·13	S. W.	4·3	6 2
February	·842	·651	·750	·786	·594	·685	73	62	69·6	36·1	50·4	34·8	9	6·04	W.	5·8	6·6
March	·896	·512	·697	·824	·466	·625	52	45	85·3	44·7	61·4	41·9	4	1·84	S. W. & W.	3 1	4·6
April	·771	·366	·587	·676	·306	·489	41	31	93·9	54·4	74·9	49·4	1	0·51	W.	2·4	3·2
May	·713	·344	·513	·650	·226	·423	53	49	100·4	62·9	78·9	58 5	8	2·74	„	2·5	4·3
June	·636	·265	·432	·474	·170	·349	68	63	95·7	60·9	78·4	57·5	20	21·82	„	5·6	5·6
July	·475	·282	·380	·394	·228	·316	85	86	87·8	70·4	76·8	69·3	24	30·83	S. & S. E.	8·1	9·1
August	·609	·298	·452	·452	·246	·366	81	74	89·3	70·0	77·4	66·6	16	23·21	W. & S. E.	7·0	6·4
September	·654	·407	·522	·575	·297	·444	78	77	88·7	65·9	75·0	64·5	14	13·80	W. & S. W.	6·1	6·2

CLASS 11.—EXTRA-DEPARTMENTAL WORK.—This consisted in reducing Lieutenant the Hon'ble H. Napier's astronomical observations for time, azimuth and latitude; it was in the hands of a pair of computers for two weeks.

TYPE PRINTING SECTION.—With the exception of 270 pages printed for other departments, the working power of this section has been solely directed to the publication of the records of this branch of the Survey Department, and to the printing of most of the office and professional forms for this office and for the tidal and levelling party.

The power of this section has been found quite equal to all the demands made on it during the year under report, as will be seen from the following statements, wherein the out-turn bears favourable comparison with those for the preceding years:—

Statement of work done during the year 1892-93.

SPECIFICATION OF PRINT.	No. of pages.	Total number of pulls.	No. of copies of each page.	Value.
				R
Professional Volumes	353	57,370	510	6,340
Synoptical Volumes	430	48,010	360	7,455
Pamphlets of spirit-levelled heights	136	6,980	360	1,708
Catalogue of stars	24	3,250	310	418
Letter-press for charts, map headings, and foot-notes	97	2,030	...	392
Forms	314	70,785	...	3,194
Extra-departmental work	270	5,097	...	492
TOTAL	1,624*	193,522	...	19,999

* Equal to 2,195 pages of standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout:—

	1888-89.	1889-90.	1890-91.	1891-92.	1892-93.
Pages composed	1,989	1,998	2,165	2,228	2,195

An analysis of the pages composed in 1892-93 is as follows:

		PAGES.
PROFESSIONAL VOLUMES	Longitude operations	324
	Tidal Volume	187
	Burma Coast Series	126
	TOTAL	637
SYNOPTICAL VOLUMES	Madras Longitudinal Series	51
	Gujarat Longitudinal Series	52
	Cutch Coast Series	143
	Madras Meridional and Coast Series	40
	Singi Meridional Series	153
	Khanpisura Meridional Series	116
	Great Arc Meridional Series	24
	Káthiawár Meridional Series	164
	TOTAL	743
MISCELLANEOUS	Catalogue of Stars	43
	Spirit-levelled heights, No. 7, Bombay Presidency	136
	Letter-press for charts, map headings and foot-notes	56
	Forms, Orders, Memoranda, etc.	364
	Extra-departmental work	216
	TOTAL	815

PHOTO-ZINCOGRAPHIC SECTION.—This section has been partly employed in printing maps, charts, diagrams, etc., to illustrate the professional and synoptical volumes and other pamphlets published by this branch, and in addition it has again executed a large amount of extra-departmental work, chiefly for the Quarter Master General's and the Forest Departments.

Owing to the pressure of work in this section and the urgent demands made by the Forest Department for working maps, it was decided at the Conference held in Simla in June 1893 that, for the present and until the strength of the section is permanently increased, cyanotype prints of the Forest maps should be given in advance of the photo-zincographed copies. This order was communicated to the section on its receipt, but

owing to the unusually cloudy weather which prevailed in July, August and September, the work did not progress as rapidly as was expected. The system has now been fairly started, and it is anticipated that a very large amount of work will be shown under this head in next year's report.

The following tables exhibit the value and out-turn of work done by this section :—

Statement showing the amount and value of work done for other departments, etc. during the year 1892-93.

Departments, etc.	Photo-zincographic Printing.								
	Sheets or Sections or subjects.	Negatives.	Photo-transfer Prints.	Line Plates.	Silver Prints.	Blue Prints.	Pulls.	Copies.	Value.
									R a.
Forest Department	66	176	296	31	...	511	2,518	3,212	2,663 9
Quarter Master General . . .	8	19	25	4	...	...	665	665	389 8
Miscellaneous	3	6	17	2	...	12	100	112	200 10
Special work done for private individuals	6	1	1	1	...	...	8	48	14 12
Cash sales	...	...	...	...	...	...	...	...	782 15
Total .	83	202	339	38	...	523	3,291	4,037	4,051 6

Statement of Departmental work done during the year 1892-93.

Specification of Plate or Print.	Progress made.	Photo-zincographic Printing.											Remarks.
		Scale of map.	Size of each sheet.	Sheets or subjects.	Negatives.	Photo-transfer prints.	Zinc plates.	Silver prints.	Blue prints.	Pulls.	Copies.	Value.	
												R a.	
Abu Meridional Series, Final Chart	F.	1 inch	8 D. E.	1	2	4	1	...	...	180	360	86 2	For Synoptical Volume XXX.
Astor and Gilgit, 1879-81	* F.	4	D. E.	1	...	...	...	...	...	100	100	21 8	
Black Mountain and adjacent countries	F.	2	½ D. E.	1	...	...	...	...	...	4	2	4 12	
Bombay Presidency, Northern portions of, Preliminary Charts Nos. 6, 7, 8, 9 and 10	* F.	4	D. E.	5	37	25	5	...	...	150	150	448 11	
Cabul and Mustagh Pass, Sketch map of country between, 1880	F.	16	D. E.	1	...	...	...	...	...	5	5	2 14	
Central Provinces Survey, Sheets Nos. 23 S.E./2, 24 N.E./2, N.W./4, S.E./1, S.E./2, S.E./4, S.W./2, S.W./3, 25 N.E./4, N.W./3, N.W./4, S.E./1, and 26 N.W./1	F. & I.	½	D. E.	13	79	54	12	...	35	1,500	1,505	1,125 9	
Chart showing the arcs of Electro-telegraphic Longitude	F.	...	½ D. E.	2	2	...	...	4	...	...	4	12 10	For Professional Volume XV.
Co-Tidal Lines,	F.	...	½ D. E.	1	...	...	...	4	...	...	4	22 8	Ditto (Tidal).
Dárdistán or Shináki including Chilás	* F.	4	½ D. E.	1	4	4	1	...	...	78	78	67 2	
Darjeeling Revisionary Survey, Sheets Nos. 1, 2, 3 and 4	* F.	½	D. E.	4	16	16	2	...	...	300	300	332 13	
Diagram of Aneroid Tidal Gauge Instrument	F.	4	1/16 D. E.	1	...	...	...	4	...	...	4	3 0	For Professional Volume (Tidal).
Forms for Departmental use (Miscellaneous)	F.	...	...	13	7	40	12	...	...	2,040	2,222	579 10	
Ditto ditto (Professional)	F. & I.	...	...	17	4	73	15	...	...	5,672	5,784	1,141 7	
Gujarat Longitudinal Series, Final Chart	F.	8	½ D. E.	1	4	4	1	...	...	360	360	95 6	For Synoptical Volume XXX.
Ditto Survey, Sheet No. 12 (2nd edition)	* F.	1	D. E.	1	9	9	1	...	...	75	75	64 14	
Isazai Expedition, 1891-92, District Hazara and Indus Valley	F.	½	D. E.	1	2	2	1	...	...	75	75	50 12	
Jaunsár Báwar Survey, Sheet No. 1	* F.	½	D. E.	1	...	...	...	...	...	50	50	10 12	
Karáchi, Tidal Diagram	I.	...	⅛ D. E.	1	1	...	...	...	...	...	...	5 11	For Professional Volume (Tidal).
Kárwár ditto	F.	...	⅛ D. E.	1	1	2	1	...	...	255	510	50 5	For Professional Volume (Tidal).
Khánpisura Meridional Series, Final Chart	F.	8	D. E.	1	7	7	1	...	...	360	360	128 6	For Synoptical Volume XXXI.
Kumaun and Garhwál Survey, Skeleton Sheet No. 9	F.	1	D. E.	1	1	9	1	...	...	100	100	73 11	
Lines of Levels in Southern India, Chart	* F.	128	1/16 D. E.	1	1	3	1	...	...	43	129	25 6	For Pamphlet of Sprit-levelled heights.
Madras Longitudinal Series, Final Charts Nos. 1 and 2	F.	8	D. E.	2	12	12	2	...	...	720	720	241 14	For Synoptical Volume XXVII.
Ditto Meridional and Coast Series, Final Charts Nos. 1 and 2	F.	8	D. E.	2	...	14	2	...	...	720	720	340 12	Ditto XXVIII.
Miranzai Expedition, 1890-91, Map of Khanki Valley (Preliminary issue)	* F.	1	D. E.	1	...	...	...	...	...	10	10	10 12	
Mussooree and Landour, Guide map	* F.	⅛	D. E.	1	...	...	...	...	...	50	50	10 12	
Northern Trans-frontier, Himalayan Peaks, Sheets Nos. 16, 23 (in one); and 14, 15, 21, 22 (in one)	* F.	16	D. E.	2	12	12	2	...	...	50	56	182 10	
North-East Trans-frontier, Sheet No. 6	* F.	8	D. E.	1	...	...	...	...	...	150	150	32 4	
Ditto ditto (in four sheets)	* F.	4	D. E.	4	...	...	...	...	...	600	600	129 0	
Ditto Himalayan Peaks, Sheets Nos. 5, 6, 12, 13 (in one); 7, 14, 15 (in one); 20, 21, 28, 29 (in one); and 22, 23, 30, 31 (in one)	* F. & I.	16	D. E.	4	24	24	4	...	...	100	100	299 5	
North-Western Provinces Survey, Sheet No. 185 N.E.	F.	½	D. E.	1	6	6	1	...	...	150	150	99 7	
North-West Trans-frontier, Himalayan Peaks, Sheets Nos. 19, 20, 27, 28 (in one)	* F.	16	D. E.	1	6	6	1	...	...	25	25	74 14	
Okha Point and Bet Harbour, Tidal Diagram	F.	...	⅛ D. E.	1	1	2	1	...	...	255	510	40 11	For Professional Volume (Tidal).
Punjab Survey, Sheets Nos. 264 S.E./4, 285 N.W./4, S.W./2, S.W./3, 286 N.W./2, 290 N.W.; 305 S.E./4, 311 N.W. 313, N.W./2, N.W./4, S. E., S.W./2, S. W./4, 314 N.E.; 331 S.W./1, 332 N. W.; and 346 S.E./4	F. & I.	...	...	17	36	11	2	...	141	175	227	516 5	

Sikkim Frontier, Captain Harman's Route in, 1882	* F.	16	½ D. E.	1	1	1	1	...	...	3	3	19	12	
Simla and Kalka Road Survey, 1881	F.	½	⅛ D. E.	1	1	...	...	...	3	...	3	7	8	
Singi Meridional Series, Final Charts Nos. 1 and 2	F.	8	D. E.	2	14	21	3	...	...	720	720	292	12	For Synoptical Volume XXXII.
Spirit-levelling Operations, No. 7, Bombay Presidency	F.	16	½ D. E.	1	4	4	1	...	...	360	360	78	3	For Pamphlet of Spirit-levelled heights.
South-West Quadrilateral of the Great Trigonometrical Survey of India, Diagram	F.	...	⅛ D. E.	1	2	7	2	...	...	392	1,176	96	6	For Synoptical Volumes.
Thayetmyo and Toungoo Secondary Triangulation, Chart, Season 1876-77	F.	4	D. E.	1	6	6	1	...	...	30	30	75	8	
Other maps for Office use, Surveyor-General's Office, etc.	F. & I.	...	...	91	275	333	69	...	...	8,659	4,986	6,140	0	

Copies of Maps of other Departments taken for Departmental use.

Assam, Index to the Forest Survey of Goálpará	F.	8	½ D. E.	1	1	1	1	...	...	15	15	3	2	
Burma (Lower), Chaungzauk Working Circle	F.	1	⅛ D. E.	1	...	2	1	...	...	20	20	5	12	
Ditto ditto Index to the Forest Survey in the E. and W. Salween and part of Attaran Division	F.	32	¼ D. E.	1	2	2	1	...	...	15	15	3	4	
Burma (Lower), Kangyi Reserve, Pegu Circle, Part of Sheet No. 228	F.	½	½ D. E.	1	4	4	1	...	...	20	20	4	4	
Burma (Lower), Laung Taung Forest, Part of Sheet No. 1	F.	1	D. E.	1	6	6	1	...	...	20	20	7	0	
„ „ North Nawin Working Circle	F.	1	⅛ D. E.	1	...	1	1	...	...	20	20	3	0	
„ „ South Nawin Working Circle	F.	1	⅛ D. E.	1	...	2	1	...	...	20	20	5	12	Copies retained for office record, of maps, etc., requisitioned for by other departments, the cost of press, pulls and stationery being all that is here charged to the Survey Department; the numbers in columns 5 to 8 therefore stand excluded from the totals.
„ (Upper), Mouk-Kunze Forest, Part of Sheet No. 1	F.	1	D. E.	1	6	6	1	...	...	20	20	7	0	
Canal Distributary and Water Course Discharge Chart	F.	...	D. E.	1	7	4	1	...	...	8	8	5	8	
Central Provinces, Indices to the Forest Survey of Districts Bhandará, Jubbulpore and Raipur	F.	8&16	⅛ D. E.	3	3	4	3	...	...	38	46	8	3	
Central Provinces, Jubbulpore Forest Survey, Sheet No. 107 $\frac{S.E.}{3}$	F.	¼	D. E.	1	7	7	1	...	...	13	13	6	2	
Dehra Dun, Lachiwalá Coppice Working Circle	F.	¼	½ D. E.	1	2	4	1	...	...	7	14	2	12	
Dutch East Indies, General map with additions up to 1887	F.	95	½ D. E.	1	3	3	1	...	...	10	10	3	0	
Kumaun and Garhwal Forest Survey, Sheets Nos. LIII (2nd edition), LIII A and LIV A	F.	¼	D. E.	3	22	25	4	...	...	45	45	19	2	
North-Western Provinces and Oudh, leased Forests in Tiri Garhwál, Nos. 226 $\frac{S.E.}{4}$ and $\frac{S.W.}{2}$, and 332 $\frac{S.E.}{2}$ and 348 $\frac{S.W.}{1}$	F.	¼	D. E.	2	13	13	2	...	...	13	13	12	4	
North-Western Provinces and Oudh, Jaunsár Bawar Division, Karamba Block, Part of Sheets Nos. 223 and 227	F.	¼	D. E.	1	4	4	1	...	...	13	13	5	5	
Punjab Forest Survey, Bashahr State, Sheets Nos. 332 $\frac{S.E.}{1}$, $\frac{S.E.}{2}$, $\frac{S.E.}{3}$, $\frac{S.W.}{1}$, $\frac{S.W.}{4}$, 333 $\frac{N.W.}{1}$, 346 $\frac{N.E.}{4}$, $\frac{S.E.}{2}$, and 347, 348 (in one)	F.	¼	D. E. & ¼ D. E.	9	39	30	6	18	...	88	98	183	0	
Punjab Forest Survey, Bashahr State, Index	F.	8	⅛ D. E.	1	1	2	1	...	...	8	16	1	15	
Sikkim, Skefeton map No. $\frac{124}{I.B.}$	F.	4	¾ D. E.	1	...	...	...	...	...	15	15	6	6	
Tibet and Western China, Sketch maps illustrating the explorations of Captain Bower, Nos. 1 and 2	F.	16	D. E.	2	16	16	2	...	...	30	30	13	0	
Other maps	F.	16&32	D. E. & ¼ D. E.	3	...	6	1	...	...	23	23	10	3	
TOTALS	...	...	...	205	577	711	147	30	179	24,977	23,261	13,358	6	

* Additional prints of previous publications; D. E. represents double elephant; F. represents finished; I. represents in press.

SOLAR PHOTOGRAPHIC SECTION.—This section has no real connection with the work of this office, but was established at Dehra Dun as a matter of convenience, so that it might be under suitable supervision.

Table of working facts for the year 1892-93.

1892-93.	NUMBER OF DAYS.				NUMBER OF NEGATIVES.										NUMBER OF WORKING DAYS WHEN SOLAR PHENOMENA WERE	
		Failures.			Solar Phenomena.								TOTAL.			
	When negatives were taken.	From bad weather.	From various causes.	TOTAL.	Spots and Faculæ		Spots only.		Faculæ only.		None.				Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″	8″	12″		
October	31	...	...	31	57	...	...	...	...	...	...	...	57	...	31	...
November	30	...	...	30	53	...	...	...	...	...	...	...	53	...	30	...
December	27	4	...	31	45	...	...	...	...	...	...	...	45	...	27	...
January	20	11	...	31	33	...	...	...	...	...	...	...	33	...	20	...
February	18	10	...	28	29	...	...	...	...	...	...	...	29	...	18	...
March	27	4	...	31	47	...	...	...	...	...	...	...	47	...	27	...
April	29	1	...	30	49	...	...	...	...	...	...	...	49	...	29	...
May	29	2	...	31	49	...	...	...	...	...	...	...	49	...	29	...
June	22	8	...	30	33	...	...	...	...	...	...	...	33	...	22	...
July	18	13	...	31	23	...	...	...	...	...	...	...	23	...	18	...
August	19	12	...	31	31	...	...	...	...	...	...	...	31	...	19	...
September	22	8	...	30	35	...	...	...	...	...	...	...	35	...	22	...
TOTAL	292	73	...	365	484	...	...	...	...	...	...	...	484	...	292	...

Seven hundred and fifty-four silver prints of the 8-inch pictures were prepared, and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table contrasting visibility of sun at Dehra Dun and Greenwich.

YEAR.	AT DEHRA DUN.			AT GREENWICH.		REMARKS.
	Number of days on which negatives were taken.	Percentage of days on which negatives showed features.	Number of days on which sun was invisible.	Year.	Number of days on which negatives were taken.	
1880-81*	307	96	55	1880	156	* From 1st October to 30th September following.
1881-82	328	100	37	1881	181	
1882-83	318	100	47	1882	221	
1883-84	285	100	78	1883	215	
1884-85	284	100	81	1884	154	
1885-86	290	100	75	1885	206	
1886-87	302	98	61	1886	199	
1887-88	328	91	38	1887	188	
1888-89	315	71	50	1887-88	205	
1889-90	320	78	45	1888-89	182	
1890-91	303	99	62	1889-90	212	
1891-92	304	100	62	1890-91†	224	† Year ending 10th May 1891. Obtained from report to the Board of Visitors.
1892-93	292	100	73	1891-92	Not obtainable.	
Means	306	...	59	...	195	

DRAWING SECTION.—The details of the work done in this section are given in the tables which follow :—

Statement showing work performed during the year 1892-93.

TITLE OF MAPS.	Number of Sheets.	Scale.	REMARKS.
		In. M.	
General Maps.			
Nepal Boundary Survey— Sheet No. 37	1	1=1	Corrected and completed.
Map of Southern Coast of Asia	1	1=96	Rough for co-tidal lines. Drawn for reduction to $\frac{1}{3}$rd scale. Final press order given.
Standard Maps.			
Hazara Expedition, 1891-92— Sheets Nos. 1, 2 and 3	3	2=1	Corrections in hand.
Isazai Expedition, 1892	1	2=1	Final press order given.
Punjab Survey— Sheets Nos. 332 $\frac{N.W.}{1}$ and 332 $\frac{N.W.}{3}$	2	4=1	Corrected and touched up for photography.
Central Provinces Survey— Sheets Nos. 23 $\frac{S.E.}{1}$, 23 $\frac{S.E.}{3}$, 23 $\frac{S.E.}{4}$, 23 $\frac{S.W.}{1}$ and 34 $\frac{N.W.}{3}$	5	4=1	Ditto ditto.
Gujarat Survey— Sheet No. 10	4	1=1	Corrected.
Plans.			
Dehra Municipality and Cantonment (2nd edition)	3	12=1	In hand.
G. T. Survey Office, Dehra	1	1=100 ft.	Corrected and completed for office use.
Quetta Civil Station	2	16=1	Corrected for 2nd edition. In press.
Index Maps.			
Triangulation Chart of India	1	1=96	Brought up to date for office use.
Index to Mandalay Meridional and Monghsat Secondary Series Preliminary Charts	1	1=40	Prepared for Annual Report
Diagram of the South-Western Quadrilateral	1	1=128	Re-drawn, and final press order given.
Lines of Levels in Southern India	1	1=128	For pamphlet of spirit-levelled heights. Final press order given.
Charts.			
Triangulation Chart, Abu Meridional Series	1	1=4	For reduction to $\frac{1}{2}$ for Synoptical volume. Final press order given
Triangulation Chart, Gujarat Longitudinal Series	1	1=4	Ditto ditto.
Triangulation Chart, Khanpisura Meridional Series	2	1=4	Ditto ditto.
Triangulation Chart, Singi Meridional Series	2	1=4	Ditto ditto.
Triangulation Chart, Cutch Coast Series	2	1=4	Ditto ditto.
Triangulation Chart No. 4 (Preliminary) Mandalay Meridional Series	1	1=4	Ditto ditto.
Triangulation Chart, Kathiawar Meridional and Coast Series	2	1=4	In hand.
Triangulation Chart, Great Arc Series, Section 8—18	4	1=4	Ditto.
Spirit Levelling Operations, No. 7, Bombay Presidency, seasons 1890-91-92	1	1=8	Corrected and completed for reduction to $\frac{1}{2}$. Final press order given.
Chart showing the Arcs of Electro-Telegraphic Longitudes	1	...	Final press order given.
Miscellaneous Maps.			
Tidal Maps of Kurrachee and Okha Point	2	Various.	For professional volume. Final press order given.
Tidal Maps of Beypore, Aden and Pamban	3	...	In press.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Statement showing work performed during the year 1892-93—continued.

Title of Maps.	Number of Sheets.	Scale.	Remarks.
		In. M.	
Miscellaneous Maps—contd.			
Tidal Maps of Port Albert Victor, Cochin, Tuticorin, Point de Galle, Negapatam, Madras, False Point, Akyab, Amherst, Moulmein, Port Blair, Trincomalli, Bhavnagar, Minicoy, Bombay, and Rangoon	16	...	In hand.
Tidal curves—Karwar, Beypore and Aden	3	...	Final press order given.
Figures of Longitudinal connections	2	...	For the engravers.
Diagram of the Commutator Board used in Electro-Telegraphic Longitudes	1	...	Corrected for the engravers.
Map of Black Mountain and adjoining country	1	1=2	Corrections in hand.
Maps coloured	2,456	Various.	

Maps examined.

	No. of Sheets.
General Maps	3
Original Standard Maps	30
Index Maps	2
Charts	13
Miscellaneous Maps	6
Photographic proofs of standard sheets and other maps	285
Total	339

N.B.—In addition to the above, many miscellaneous jobs have been performed, such as assisting in Photographic Office, completing Central Provinces Survey, Punjab Survey, and Forest Survey and other original maps in respect to headings, footnotes, etc., for press; supplying tracings of margins of sheets to Simla Drawing Office, No. 18 Party, and to the Commissioner of the Presidency Division; examination and custody of records; and pasting together of Cyanotype prints of standard sheets for Forest Department. During the year under report this section made all the despatches of maps.

Statement of work done for other Departments, etc., during the year 1892-93.

Title of Maps.	Number of Sheets.	Scale.	Remarks.
		In. M.	
General Maps.			
General Map of Dutch East Indies	1	1=95	Completed headings and footnotes for Quarter Master General. Final press order given.
Standard Maps.			
Forest Surveys	33	Various.	Completed headings and footnotes and references. Final press order given for Forest Survey Branch.
Index Maps.			
Forest Surveys	8	...	Ditto ditto.
Miscellaneous Maps.			
Forest Surveys	13	...	Ditto ditto.

Statement showing the value of work done for the other Departments, etc., during the year 1892-93.

Departments, etc.	Value. R	Value. a.
Quarter Master General's Department	10	0
Forest Survey Department	112	0
Total	122	0

C. I. C. P. O.—No. 19 S. G.—20-4-94.—459.

1894.

File No. 88.

Serial No. 2.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

SURVEYS.

RESOLUTION.

Resolution No. $\frac{5}{88}$.

Dated Simla, the 4th June 1894.

SUBJECT.

Reviews the General Report on the operation of the Survey of India Department during 1892-93.

G. C. Press, Simla.—No. 236 R. & A. D.—5-6-94.—720.

Resolution No. $\frac{5}{88}$.

Extract from the Proceedings of the Government of India in the Department of Revenue and Agriculture (Surveys), dated Simla, the 4th June 1894.

READ—

General Report on the operations of the Survey of India Department during 1892-93.

RESOLUTION.

During the year ending 30th September 1893 the field operations of the Survey of India Department were carried on by twenty-one parties and three small detachments in connection with the various classes of work indicated in the following list :—

Class of work.	No. of parties.	No. of detachments.
1. Trigonometrical	1	...
2. Topographical	3	2
3. Forest	4	...
4. Cadastral	7	1
5. Traverse	1	...
6. Scientific	3	...
7. Geographical	2	...
TOTAL ...	21	3

Twelve of the parties and one detachment, *viz.*, those coming under the heads of Forest, Cadastral and Traverse were engaged on remunerative operations, *i.e.*, on work which leads to enhancement of land or forest revenue or to economy in administration.

2. The aggregate area surveyed in detail by the whole Department during the year was 104,711 square miles against a total of 80,101 square miles during the previous year.

As in the previous year, one party was employed on trigonometrical operations in the newly acquired territory of Upper Burma, where 70 miles of principal and 104 miles of secondary series were accomplished during the year, and three parties with two detachments were engaged on topographical survey, their operations covering ground in the Bombay Presidency, in Baluchistan, in the Punjab Himalayas, in three districts of Burma, and in the valley of the Lower Indus; the areas topographically surveyed amounted to 10,215 square miles against 9,909 square miles in the previous year. Surveys in two districts of Burma were made on behalf of the Geological Department in connection with the development of mining industries, in Mergui the coal deposits, and in Katha the gold fields, having been explored.

3. The total outturn effected by survey parties working in forests in the Central Provinces, Bombay, Madras and Lower Burma was 2,170 square miles. The outturns in the Central Provinces and Madras were, in spite of the unhealthy season in the former, more satisfactory than elsewhere, and the Government of India hope to see better progress in other provinces next season. The work done by the Forest Survey Branch is not included in the Surveyor-General's notice of forest surveys. Although it is under the general direction of the Inspector-General of Forests, it is controlled by officers of the Survey Department, and, unless there is any practical objection to the course, it would be convenient if a review of it were to find a place in future annual reports. The cost rate of the Madras forest surveys has been reduced by 20 per cent. to Rs. 78 a square mile, but the rates elsewhere appear from the table of rates on page 96 to have been considerably over Rs. 100, and in Lower Burma amounted to something over Rs. 300 for 4-inch surveys. Nothing appears in the extracts from the Forest Survey Reports to justify these higher rates, though in Burma the Government of India are aware that great difficulties have to be encountered. The extracts deal rather with incidental matter than with the financial results, and it would be preferable that in future reviews the causes by which cost rates were affected should be prominently quoted from the reports submitted.

4. The most important operations have, as usual in recent years, been those connected with cadastral survey. As was noticed in last year's report, Colonel Sandeman has in Bengal given much effect to the policy which has been there adopted of amalgamating the survey with the settlement Department. The cost rate in Bihar is still above the level which it is hoped will be reached when the subordinates have had further practice and experience. The somewhat extravagant rates in Garhwal, where the survey party had been required to do work in greater detail than was really necessary, have been reduced from the original figure of Rs. 283 to Rs. 167 per square mile, the latter rate being as low as can be expected in a mountainous district. The area covered by all the parties is in the aggregate nearly 10 per cent. larger than that which was cadastrally surveyed last year, and this is satisfactory.

5. One of the most important reforms to which experience in cadastral work has led has been, as noticed last year, the employment of Officers of the Junior Division on more responsible work and the expansion of cadastral parties under the supervision of each Senior Division Officer. This double reform has diminished the cost rate of supervision, and has admitted of the reduction of the Senior Division Staff. Some set off has been made against the saving by improving the position and pay of the Junior Service as shown in the following table:—

Former scale.	Pay.	Present scale.	Pay.
	Rs.		Rs.
50 Extra Assistant Superintendents	300—500	60 Extra Assistant Superintendents	300—550
85 Sub-Assistant Superintendents	120—250	72 Sub-Assistant Superintendents	120—250

The policy adopted is now shown to be justified both by lower cost rates and by more rapid progress. It is expected that the decline in cost rates and the improvement in progress will continue for some time to come, and the Surveyor-General is to be congratulated on having introduced this effective reform.

6. The measure which had during the last few years been contemplated of reducing the appointment of one of the two Deputy Surveyors-General and of abolishing the Trigonometrical Office at Dehra, when the triangulation of the empire had been brought nearly to a close, was partially carried out by the end of the year 1893-94. Although the report under review only concerns the preceding year 1892-93, it is desirable to note that the original intention has, with the sanction of the Secretary of State, been so far modified that in place of the Deputy Surveyor-General an officer of junior rank has been appointed in charge of the Dehra office, which, in view both of the expansion of triangulation operations in Upper Burma and on the North-Western frontier, and of the utility of the Dehra office for the forest cartographical work which could not, without inconvenience, have been thrown on the already overcrowded Calcutta office, is still to be maintained.

7. A measure which has had much to do with the increase of work in the Calcutta office was carried out towards the close of the year under review, *viz.*: the reorganization of the Photographic and Lithographic office, in which the outturn of the presses and machines have now reached the number of a million pulls, or more than 30 per cent. over the number of the preceding year. The value of the work done was nearly two and a half lakhs of rupees. Colonel Waterhouse, to whom the progress made in this section is greatly due, deserves the thanks of the Government of India for his energetic and able supervision of his special Department.

8. The control of the Revenue and Cadastral Surveys by Colonel Strahan, Deputy Surveyor-General, has been zealous and effective, and he has fully carried out the instructions of the Government of India to keep himself in personal communication with the Local Governments of Provinces in which revenue surveys are being conducted. The work of the Department in all branches under the guidance of Colonel Thuillier, C.I.E., R.E., again deserves the commendation of the Governor-General in Council.

ORDER.—Ordered that the above Resolution be forwarded to the Surveyor-General, Inspector-General of Forests, Local Governments and Administrations noted on the margin, and to the Foreign, Military, and Public Works Departments.

Madras.	Punjab.
Bombay.	Central Provinces.
Bengal.	Burma.
North-Western Provinces and Oudh.	Assam.
	Coorg.

Ordered also that the Resolution be published in the Supplement to the *Gazette of India*.

(True extract.)

E. C. BUCK,

Secretary to the Government of India.

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Government of Maharashtra

on 01 February, 2020